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THE HYDROSOCIAL COSTS OF HIGH-VOLUME HYDRAULIC FRACTURING: A TALE OF TWO COUNTIES IN MICHIGAN

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THE HYDROSOCIAL COSTS OF HIGH-VOLUME HYDRAULIC FRACTURING: A TALE OF TWO COUNTIES IN MICHIGAN

By

Amanda Kreuze

A THESIS

Submitted in partial fulfillment of the requirements for the degree of

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In Environmental and Energy Policy

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This thesis has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Environmental and Energy Policy.

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Abstract

Although natural gas has been praised as a clean and abundant energy source, the varying impacts and uncertainties surrounding the process of extracting natural gas from unconventional sources, known as horizontal high-volume hydraulic fracturing (HVHF) or "fracking," have raised important concerns. The practice of HVHF is expanding so quickly that the full impacts are not yet known. This thesis project, using a grounded theory methodological approach, explores the risks and benefits associated with HVHF as recognized by the residents of two Michigan counties, one that currently produces natural gas by HVHF (Crawford County) and one that does not (Barry County). Through an analysis of media content related to HVHF in each case study site and interviews with stakeholders in both counties, this study examines perceptions of risks and benefits by comparing two communities that differ in their level of experience with HVHF operations, contributing to our understanding of how perceptions of risks and benefits are shaped by natural gas development. The comparative analysis of the case study counties revealed similarities and differences between the case study counties. Overall, Barry County residents identified fewer benefits and more risks, and had stronger negative perceptions than Crawford County residents. This study contributes to the social science literature by developing a richer theoretical frame for understanding perceptions of HVHF and also shares recommendations for industry, organizations, regulators, and government leaders interested in effectively communicating with community stakeholders about the benefits and risks of HVHF.

Chapter 1: Introduction

Recent developments in horizontal drilling and high-volume hydraulic fracturing (HVHF) technology allow extraction of natural gas from unconventional sources. Proponents of HVHF argue for an increased production of natural gas and praise HVHF as providing access to a clean and abundant energy source, while opponents question the many uncertain impacts to communities and the environment. The practice of HVHF is expanding so quickly that the long-term impacts to communities and the natural environment are not yet known (Jacobson et al., 2013; North, Stern, Webler, & Field, 2014; Small et al., 2014). While some of the various benefits and risks of HVHF have been examined, controversies and misconceptions still exist (Boudet, et al., 2014; Perry, 2012; Sovacool, 2014). Researchers emphasize the importance of conducting longitudinal studies and comparative studies among different locations to better understand perceptions and identify relationships or differences (Brasier et al., 2011; Ladd, 2013; Perry, 2012). Studies of public perceptions of HVHF have provided important insights, however most of this work focuses on Pennsylvania, New York, Texas, and Colorado (Ladd, 2013; Theodori, 2009).

This thesis project identifies and characterizes the risks and benefits associated with HVHF as recognized by the stakeholders of two Michigan counties,[1] one that currently produces unconventional natural gas (Crawford County) and one that does not (Barry County) (see Figure 1 in Appendix A to view a county map of Michigan). This study assesses the extent to which perceptions of the risks and benefits associated with HVHF are associated with the presence of HVHF operations. Through interviews with

[1] See this paper's definition of stakeholder on page 7.

stakeholders, this study examines perceptions of risks and benefits by comparing two communities that differ in their level of experience with HVHF operations. A grounded theory approach was used to develop and answer a hypothesis regarding public perceptions of HVHF between communities with differing levels of activity. Review of the academic literature on HVHF informed this thesis' null hypothesis that the presence of active HVHF operations will not have an impact on stakeholder perceptions. The research hypothesis guiding this project suggests that the case study counties will share similar perceptions on HVHF. Based on review of scholarly literature, this thesis also expected responses associated with an increase in the United States energy independence and a reduction in CO_2 emissions would be the most common benefits of HVHF identified by stakeholders equally in both counties. This thesis also expected responses associated with risks related to the large use of freshwater and of water contamination would be most common risks identified by stakeholders equally in both counties.

The hypothesis was tested first through a content analysis and then subsequently through interviews, to improve theory about how perceptions of the risks and benefits of HVHF differ in communities with dissimilar levels of firsthand experience with the process. This thesis aimed to determine whether or not the presence of unconventional natural gas development influences community perceptions of HVHF. This study contributes to the social science literature by developing a richer theoretical frame for understanding how community perceptions of HVHF are correlated with unconventional natural gas development as well as providing policy recommendations for organizations and community leaders.

Definitions

The abbreviation "HVHF" used throughout this paper refers to the horizontal drilling and high-volume hydraulic fracturing technique used to produce natural gas from unconventional sources. It must be noted that within the industry, the term 'fracking' is only used when referring to the fracturing of a well; however, stakeholder perceptions of 'fracking' are also associated with its related activities (e.g. construction of the well pad, drilling and fracturing, production of natural gas, plugging of well, and the post-production life of the well) (Ernstoff & Ellis, 2013). Crawford County and Barry County are the two units of analysis of this study. The individual stakeholders interviewed served as the unit of observation. The term "stakeholder" refers to residents or individuals with involvement, authority, or influence within the county (Mitchell, Agle, & Wood, 1997). The term "community" refers to both the geographic (county boundaries) and the relational (professional relationship; e.g. individuals who work inside the county boundaries or individuals involved with organizations inside the county boundaries, but live outside of the county boundary) aspects of each community (McMillan & Chavis, 1986).

Outline

The literature review in the next section discusses the main benefits and risks of HVHF and public perceptions of HVHF as described in scholarly literature. In addition, it includes a discussion of how the media and politics play a role in shaping perceptions. Chapter three includes a brief discussion of HVHF in Michigan and relevant background information for Crawford County and Barry County. Chapter four provides a description

of the study's methodology. The methods used to conduct this study include a content analysis of popular media sources and interviews with stakeholders, utilizing a grounded theory perspective to inform the methodology and guide data analysis. Chapter five presents a summary and comparison of the media content analysis and findings from the interview analysis. Chapter six contains a discussion of the research findings, provides social science explanations of these results and discusses the significance of the findings. The conclusion rearticulates the key themes that emerged in the analysis and presents valuable recommendations for community leaders, government departments, and organizations in the regulations of and decision-making regarding HVHF at a local level.

Chapter 2: Public Perceptions of High-Volume Hydraulic Fracturing: A Literature Review

Natural gas supplies 21% of total electricity generation and 24% of total energy generation in the United States (Gregory, Vidic, & Dzombak, 2011). Annual production of natural gas has increased greatly since 2000,[2] with predictions that it will triple within a decade. Allowing for such growth is the production of unconventional natural gas (e.g. tight shale, tight sand, and coal bed methane) (Gregory et al., 2011; Kharaka, Thordsen, Conaway, & Thomas, 2013; Perry, 2012). The State of Michigan contains the Antrim Shale and Utica-Collingwood Shale formations. These sources are considered unconventional due to their geological location and the low permeability of their formations (North et al., 2014; Ratner & Tiemann, 2014) (refer to Figure 2 in Appendix A to see a map of Michigan's bedrock). Due to these factors, they usually require more effort to extract the gas than do conventional sources (Ellis, 2013).

Although many supporters argue that natural gas drilling and production technologies have been utilized since the 1940s, the new horizontal drilling methods to obtain unconventional gas have only expanded in the last decade (Sovacool, 2014). The process involves new techniques that differ from conventional wells, in that the wells typically reach thousands of feet deeper, utilize horizontal drilling methods, use much larger volumes of water,[3] and inject larger amounts of fracture fluid (Brantley et al., 2014; Ellis, 2013). A high-volume hydraulic fracturing well completion is defined by the

[2] 0.4 Tcf in 2000 to 6.8 Tcf in 2011 (Gregory, Vidic, & Dzombak, 2011).
[3] Vertical well use approximately 500,000 gallons of water to fracture. Horizontal wells use approximately 2-7 million gallons of water to fracture (Brantley et al., 2014; Ellis, 2013; Ernstoff & Ellis, 2013)

Michigan Department of Environmental Quality (MDEQ) as "a well that is intended to use a total of more than 100,000 gallons of hydraulic fracturing fluid" (MDEQ, 2013a). The process begins by first drilling a vertical well into the earth's surface to the depth of the formation. Next, at the depth of the vertical well, a horizontal well is drilled into the formation. Then, a high-pressure pump injects a large volume of fracture fluid comprised of water, sands, and chemicals into the well. The high water pressure creates fissures in the formation, the sand holds the cracks open, and the chemicals dissolve any minerals or organic matter that may be present. Once this process is complete, the fluid is pumped as a brine solution to the surface, known as flowback, and then the natural gas is pumped to the well (Burnham et al., 2012; Gregory et al., 2011; Wilson & Schwank, 2013).

According to Rogers (2011), unconventional natural gas sources first became an economically viable option between 2000-2008. During this time, natural gas prices were rising due to the declining production of conventional sources (Rogers, 2011). In 2011, approximately 33% of the United States natural gas was produced from shale gas (Ratner & Tiemann, 2013). The United States produced about 95% of the natural gas consumed in the United States in 2011 (Barteau & Kota, 2014). According to energy predictions, 50% of the natural gas produced in the United States will be sourced from shale gas by 2030 (Sovacool, 2014).

Benefits and Risks from High-Volume Hydraulic Fracturing

A 2012 analysis of natural gas reported that, "because of the low prices of natural gas, it is expected the average U.S. household will save $926 per year in disposable income between 2012 and 2015" (Michigan House of Representatives, 2012, p.2). The

primary benefits of HVHF include: an abundant supply of natural gas, lower energy prices, lower carbon dioxide emissions, local economic development, an opportunity for growth for the chemical industry, and new jobs (Jacquet, 2014; Sovacool, 2014). A comparative study of two counties in Texas found that the key stakeholders interviewed perceived as benefits the increasing economic revenue and property values, a growing job market, and improving public services from the presences of unconventional natural gas drilling (Theodori, 2009). Private landowners who lease land and/or mineral rights to oil and gas companies receive an income from the lease (Jacquet, 2014). If significant, it can increase income tax revenue to the local community. If the HVHF activities take place on state owned land, then the state may also receive an increase in revenue from leases payments, royalties, and severance taxes, if they charge one (Brasier et al. 2011).

The local economic benefits are considered short-term benefits because of the short operation life of many wells. The beginning stage of natural gas production yields high volumes, but the production then quickly declines, with some wells already complete within 12-18 months of production. Although HVHF brings economic benefits during the production phase, there is a possibility it will leave long-term consequences to communities (Christopherson & Rightor, 2012). Areas that heavily rely on tourism are especially vulnerable because the activities can change the rural character and reputation of the area, which can result in significant economic degradation in the long-term (Rumbach, 2011).

The primary potential risks associated with HVHF include: technological complexities and risks of poor operating practices, degradation to the environment, contribution to climate change, displacement of renewable energy sources, social

opposition, increased seismicity and earthquakes, uncertainties in predicting profitability, and harms to public health from water pollution, air pollution, and the release of radiation (Sovacool, 2014). Small et al. (2014) also identify risks to employees during operation of the well pad, effects on public health and ecosystem health, socioeconomic and community effects, and the possibility for synergistic and cumulative impacts. The Theodori (2009) comparative study revealed that the key respondents interviewed perceived the volume of freshwater used, depletion of aquifers, and water pollution as all increasing as a result of the unconventional natural gas drilling.

The Congressional Report of the chemicals used in the hydraulic fracturing fluids between 2005 and 2009 found that "the 14 oil and gas service companies used more than 2,500 hydraulic fracturing products containing 750 chemicals and other components" (U.S. House of Representatives, 2011, p.1). The total volume of fracturing products used by these companies was 780 million gallons (this reflects the fracturing products used alone and does not include any of the water added on-site) (U.S. House of Representatives, 2011). Reported additives in the fluids include common components as well as toxic components, such as: Benzene, Toluene, Xylene, and Ethylbenzene (BTEXs). Furthermore, over 650 of the fracking products reported are comprised of at least "one or more of 29 chemicals that are (1) known or possible human carcinogens, (2) regulated under the Safe Drinking Water Act for their risks to human health, or (3) listed as hazardous air pollutants under the Clean Air Act" (U.S. House of Representatives, 2011, p. 1).

Noise from trucks, drilling, generators, and other well pad operations can disturb residents living nearby (Adgate, Goldstein, McKenzie, 2014). Each well pad contains a

compressor station, which runs continually for 24 hours a day emitting noise levels in the 85-95 decibel range, although OSHA regulations only allow noise levels of this decibel range for an 8-hour day (Christopherson & Rightor, 2012). In addition to noise, light and air pollution are also cited as health concerns (Korfmacher, Jones, Malone, & Vinci, 2013). The excess lights at HVHF well pads have interrupted some nearby residents sleeping patterns. Residents have also reported bad smells coming from HVHF sites. The noise, light, and air pollution can all generate added stress to nearby residents (Korfmacher et al., 2013). The industry is also associated with the boom and bust cycle, which creates rapid socioeconomic changes in a community and can create many negative social impacts to the residents (Schafft, Borlu, & Glenna, 2013). The influx of newcomers can also change the social structure and community identity, which can lead to increased stress, tensions, disagreements, and an overall reduced quality of life (Boudet et al., 2014; Schafft et al., 2013).

The benefits and risks of HVHF vary among communities as well as within communities (Sovacool, 2014). The well site, lease type (e.g. private or public), and the size and location of the community all play a role in the types of positive and/or negative impacts a community may experience (Jacquet, 2014; Small et al., 2014). Some communities have experienced many benefits and few negative impacts, while some other communities have had to deal with a host of negative impacts from HVHF activities (Sovacool, 2014). Within communities, landowners who have signed oil and gas leases receive payments, but the other residents in the community do not receive a financial benefit and are not compensated for the negative impacts associated with HVHF (Jacquet, 2014). A greater understanding of how certain types of communities are at

higher risk of the presence of HVHF and the impacts associated with them is needed. For example, rural communities tend be those at higher risk because they primarily use well water and the U.S. Environmental Protection Agency (EPA) does not have authority to regulate private wells, leaving it up to the well owner themselves to ensure the safety of their water (Perry, 2012). The case study counties, Crawford and Barry, are both described as rural communities. About 70% of Crawford County's land area is public land, whereas less than 10% of the land area in Barry County is public land (Barry County Equalization Department, personal communication, February 13, 2015; NEMCOG, 2014). The population size of Barry County is larger and unlike Crawford County, it is located between three metropolitan centers (Budget, 2013; US Census Bureau, 2014).

Water Resources

Several studies report that the amount of water needed for HVHF ranges between two and seven million gallons per well, but some wells may use more or less water because each shale play has different characteristics and each well varies in its depth and in its number of HVHF stages completed (Brantley et al., 2014; Entrekin, Evans-White, Johnson, & Hagenbuch, 2011; Ernstoff & Ellis, 2013; North et al., 2014). For example, an Encana Oil and Gas USA well, the State Excelsior 3-25 HD-1 located in Michigan's Kalkaska County required a total of 21.1 million gallons of water to complete (Ban Michigan Fracking, 2014; Ellis, 2013). These estimates reflect the volume of water used only to fracture the well; companies do not have to report the volume of water used to drill the well (FARWatershed & respectmyplanet, 2014).

The source of water (e.g. on-site or off-site) also varies by well location (Ernstoff & Ellis, 2013). Typically, the water used for HVHF wells in Michigan is groundwater withdrawn from the site. In locations without a sufficient volume of water on site, water must be trucked in (Ban Michigan Fracking, 2013; Clean Water Action, n.d.). Ernstoff & Ellis (2013) mention that the volume of water used for HVHF is often comparable to other industries (e.g. mining), however the process withdraws a larger volume of freshwater over a short period of time. This may impact the local area, especially if the area has shallow aquifers, is enduring a drought, or if other industries (e.g. agriculture) are also withdrawing water (Ellis, 2013; Entrekin et al., 2011). Large freshwater withdrawals may reduce the public's supply of available water and reduce stream flow of nearby rivers or streams. The preliminary report of an ongoing Michigan State University (MSU) study discovered three important findings: (1) the stream flow of the Au Sable River and Manistee River headwater areas are considerably overestimated by the Water Withdrawal Assessment Tool; (2) the proposed and permitted water withdrawals for HVHF in the headwaters areas of the Au Sable River and Manistee River will likely significantly reduce the stream flows of these areas; (3) the water withdrawals for the Excelsior 1-13 HVHF well in October 2013 dramatically reduced the stream flow in the North Branch of the Manistee River, causing it to "drop down close to 0cfs on the first day of the fracking operations" (Anglers of the Au Sable, 2015). In addition, the development of the well pad and construction of new roads may increase runoff and lead to increased sediment in nearby surface waters (Entrekin et al., 2011).

The risk of contamination to both groundwater and surface water sources from the flowback water represents another major concern. The flowback water contains high

levels of salts, metals, chemicals, organic compounds, and radioactive materials (Gregory et al., 2011; Kharaka, 2013; Rahm et al., 2013). In Michigan, approximately 37% of the fracture fluid returns to the surface, where it is temporarily stored in enclosed, steel tanks until disposal through deep well injection. Reports of increase seismic activity from underground injection and worries about the potential migration of gases from flowback water have raised criticism of this disposal method (Ellis, 2013; Kharaka, 2013). Furthermore, disposal of flowback water through deep well injection permanently removes the water from the hydrologic cycle (Ernstoff & Ellis, 2013). Michigan does not have any requirement for the water to be reused for other HVHF operations (FARWatershed & respectmyplanet, 2014). The large use of freshwater and potential for contamination not only poses risks to the environment, but to the communities in which HVHF takes place.

Private Versus Public Ownership

HVHF can take place on either private or public land. The location and type of land on which HVHF takes place can also spur conflicts at locations with split estate situations and when states lease state-owned mineral rights to oil and gas companies. This section discusses mineral rights ownership and presents a review of differences in perceptions of HVHF on public and private land, as presented in previous scholarship.

Private landowners who own surface land and mineral rights have the option to sell or lease their land and/or mineral rights to interested companies. How uniform or divided the benefits and costs from HVHF are within a community largely depends on the owner of the land and the owner of the mineral rights. When companies lease mineral

rights from private landowners, the payments go to one resident (Jacquet, 2014). The private mineral rights owner and the company negotiate the royalty amount. In most Michigan contracts between private landowners and companies, the royalty payment amount that the private landowner receives is typically one-eighth of the company's earnings from that site. A private landowner who leases the minerals under their land may experience increased property values during the phase of natural gas production, as long as no negative consequences occur. However, other neighboring landowners may experience a decrease in their property values. This decline is likely due to perceptions of the potential risks associated with the activity along with the lack of any financial benefit of having a well pad nearby (Zullo & Zhang, 2013).

Issues can occur when surface landowners do not own the mineral rights below the surface (Jacquet, 2014). This conflict of split estate is common in Michigan and in many other states with HVHF (Willow & Wylie, 2014). When there is a difference in the surface landowner and the subsurface owner, there can be lasting impacts on the value of the land, future investments and sales, and value of the home, if there is one on the property (Jacquet, 2014). Furthermore, surface owners are seldom aware that they have unconventional natural gas underneath their land, so companies are often able to obtain leases before the surface owners have time to react (Willow & Wylie, 2014). The State of Michigan has also begun to lease mineral rights under public lands, leading to tensions between the public and the state (Jacquet, 2014). The public's reactions and the distribution of risks and benefits in a community depend on who owns the land, who owns the mineral rights, and who makes the decisions and regulates the HVHF process.

Exemptions and Regulations

HVHF is exempt from numerous federal laws, including the Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Clean Water Act (CWA), Solid Waste Disposal Act (SWDA), Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Emergency Planning and Community Right to Know Act (EPCRA), and the National Environmental Policy Act (NEPA) (Brady, 2012; Hammersley & Redman, 2014). These federal exemptions place the responsibility on states to regulate the natural gas industry (North et al., 2014). In Michigan, oil and gas companies are also exempt from the State's Water Withdrawal Statute (Part 327). The State does have a Water Withdrawal Assessment Tool designed to assess the potential impacts of proposed water withdrawals at well sites. The MDEQ requires oil and gas operations planning to withdraw over 100,000 gallons of water per day for 30 consecutive days complete the water withdrawal evaluation (MDEQ, 2011). Even so, the effectiveness and accuracy of the tool has been strongly critiqued (Anglers of the Au Sable, 2015).

Natural gas companies using HVHF techniques in Michigan do not have to disclose the chemicals used in their fracture fluid until 60 days after the well has been completed (Ellis, 2013). Without knowing the composition of the HVHF fluid, it is impossible to accurately identify the risks to humans and ecosystems. This raises important concerns over how to handle potential spills, illness from contamination, and how to determine what (if any) wastewater treatment method should be used (Hudgins & Poole, 2014; U.S. House, 2011). In 2009, the Fracturing Responsibility and Awareness of Chemicals Act (FRAC Act), was presented to the U.S. House and the U.S. Senate, but

failed to pass. The FRAC Act would have repealed the SDWA exemption and required full chemical disclosure to the state and the public (Warner & Shapiro, 2013). The HVHF exemptions and the lack uniform federal regulations over HVHF activities raise important policy questions.

States hold the responsibility to regulate the industry, but often lack the capacity to do so. The State of Michigan currently has 30 inspectors responsible to oversee 25,000 active wells (Snow, 2014). The natural gas companies have tried to keep regulatory oversight at the state level, while those concerned with HVHF have attempted to increase regulations overall and called for more oversight by the U.S. EPA (Davis & Hoffer, 2012; Smith & Ferguson, 2013). Protests, rallies, petitions, and lawsuits have arisen out of discontent with the regulatory framework. Most of the conflicts that have occurred with the current HVHF regulations have taken place at the state and local level, but conflicts between states have also arisen because of trans-boundary issues. The Michigan Zoning and Enabling Act of 2006 prohibits counties and townships from regulating or controlling the "drilling, completion, or operation of oil and gas wells or other wells drilled for oil and gas exploration purposes and shale not have jurisdiction with reference to the issuance of permits for the location, drilling, operation or abandonment of such wells" (Michigan Legislature, 2009). City and county governments in Michigan currently do have the authority to use their zoning and police powers to implement ordinances, require bonds, or additional permits to regulate ancillary activities (anything except for activities on the well pad) as long as they do not conflict with the State's rules (Freilich & Popowitz, 2012; Warner & Shapiro, 2013). Local governments should take a role in regulating the ancillary activities of HVHF in their communities and should also

communicate with state legislatures about increasing their authority to also regulate activities on the well pad itself (Freilich & Popowitz, 2012).

Politics and Science in the High-Volume Hydraulic Fracturing Debate

Scientific studies have not been able to keep up with the rapid surge in the extraction of shale gas (North et al., 2014). In 2011, the U.S. EPA planned a study to assess the risks HVHF may pose to the nation's drinking water resources. Unfortunately, the EPA was limited in their scope due to political debate and industry lobbying and had to make certain exceptions when analyzing surface spills, wastewater, and environmental justice matters in their study (Perry, 2012). The operator of a municipal water treatment plant remarked: "politics now drives decisions and not science," after receiving large volumes of flowback water that the plant was unable to properly treat (Hudgins & Poole, 2014, p. 304).

Freudenburg & Alario (2007) argue, "capitalist societies collectively produce wealth that is concentrated in private hands" (p. 150), which draws attention to the unequal distribution of costs and benefits in the American economic system. Those concerned with the process of HVHF argue that the state is placing the interests of the industry before environmental and public health (Davis & Hoffer, 2012). An example of this is Pennsylvania's decision of Act 13 (unconventional drilling law). Governor Tom Corbett was responsible for appointing members to the committee to review the Act. No social scientists or public health experts were appointed to the committee and only one academic (whose research was funded by natural gas companies) was appointed to the committee (Hudgins & Poole, 2014). Tom Corbett received $1.8 million dollars between

2010 and April 2012 from the natural gas industry. The governors of Pennsylvania and Maryland as well as President Obama have all claimed that health risks are a main concern associated with the HVHF activities, yet at both the state and federal levels, no public health officials have a position on any unconventional natural gas drilling commissions (Hudgins & Poole, 2014). Narrowing the experts chosen to sit on decision-making groups helps the state promote a good business climate for industry, further promoting capital's success and limiting the public's voice (Hudgins & Poole, 2014).

Public Perceptions

HVHF embodies a highly controversial topic, often with very extreme opinions, but how knowledgeable are Americans about it? Table 1 displays the findings from three studies that either polled or surveyed the American public, asking them their awareness level of HVHF and whether they support or oppose HVHF. The Infogroup/ORC study (2010) found that for those very or somewhat aware, 69% were worried about water quality in relation to fracking and 78% would support "tighter public disclosure requirements as well as studies of the health and environmental consequences of the chemicals used in natural gas drilling" (Infogroup/ORC, 2010). In addition, a 2012 Bloomberg national poll found American support for increased tighter regulations of fracking was 65% (Drajem, 2012). The Pew Research Center (2012) found that those who had heard of it were divided in their opinions, with 52% in support of fracking and 35% opposed to fracking.

Table 1: Awareness Levels and Opinions of HVHF Held by the American Public

Study	Awareness Level	Opinion
(Infogroup/ORC, 2010)	45% were very or somewhat aware of fracking as an issue	--
(Boudet et al., 2014)	9% heard a lot about it 22% heard a little about it 16% heard some about it 35% heard nothing about it	58% did not know whether they supported or opposed of HVHF
(Pew Research Center, 2012)	29% heard a lot about it 37% heard a little about it 37% heard nothing about it	52% support 35% oppose

The findings of the Civil Society Institute's 2010 survey is inconsistent with the 2012 surveys of awareness and opinions reported by Boudet et al. (2014) and the Pew Research Center, but was consistent with the 2012 Bloomberg nation poll. This study explains that the inconsistencies are a result of sampling respondents in different regions. The Civil Society Institute surveyed New York and Pennsylvania residents, who already had experienced a large HVHF boom prior to the study. Boudet et al. (2014) and the Pew Research Center surveyed Americans in every region of the U.S., many of whom have had very little HVHF activity compared to that of New York and Pennsylvania. The Pew Research Center's survey found that Americans living in the Northeast were much more likely to have heard a lot about fracking than Americans in living in the rest of the country (23% had heard a lot) (Pew Research Center, 2012).

Stakeholder perceptions of the benefits and risks of HVHF to communities fall into three main categories: social, economic, and environmental (Ladd, 2013; Theodori, 2009). A study compared perceptions in two Texas counties, one that has a more established natural gas industry with one that has a less established natural gas industry. Of the 30 items listed in the survey, respondents perceived 24 of them as negative social or environmental impacts. The increase in truck traffic was the most commonly shared negative impact in both counties. Perceptions in the two counties did differ regarding other positive and negative impacts listed in the survey, suggesting that residents in counties with differing levels of natural gas development view the potential issues of the industry to their county differently (Theodori, 2009). Theodori's study uses a similar design as this thesis and thus informed my hypothesis of public perceptions of communities with dissimilar levels of HVHF activity.

Ladd (2013) examined perceptions held by stakeholder groups and residents in the Haynesville Shale formation, located in Louisiana. This study found "improved local economy/buffered recession" was the most commonly perceived socioeconomic benefit of HVHF and "truck traffic/congestion/accidents" was the most commonly perceived socioeconomic impact of HVHF (Ladd, 2013, p.72-73). The most common perceived environmental benefit identified was "reduced CO_2 emissions/air pollution/coal usage" and the most commonly identified negative environmental impact was the "amount of freshwater used to drill/frack wells" (Ladd, 2013, p.72-73).

A public perception survey of 6,000 households in the drilling regions of New York and Pennsylvania revealed that perceptions differed based on how residents viewed their relationship with the natural environment. Residents who viewed the natural

environment for the usable services it provides perceived lower risks from HVHF, whereas residents who believe humans are interconnected with the natural environment perceived higher risks from HVHF. In responses to the survey, 58% of the respondents believed the negative impacts of HVHF can be avoided and only 22% of the respondents believe remediation is possible if negative impacts do arise (Christopherson & Rightor, 2012). In response to the varying perceptions of risks, uncertainties, and negative impacts experience in some locations, a few countries, states, and cities have implemented bans, moratoriums, or ordinances (Christopherson & Rightor, 2012). More recently however, there has been some pushback against local bans. Ohio, for example, recently passed a ruling prohibiting local governments from using these powers to prevent or restrict HVHF (Colman, 2015).

Influences from Media and Industry

The media acts as a main source of information for the public, and thus strongly influences public opinion and decisions (Davis & Hoffer, 2012; Freudenburg & Alario, 2007). Along with the media, the industry also plays a strong role in how the public understands and views natural gas production (Freudenburg & Alario, 2007; Hudgins & Poole, 2014). Natural gas companies (along with state officials) attempt to dominate the HVHF discourse and generate stronger support, by presenting HVHF in a light that only highlights the benefits and disregards concerns as irrational (Davis & Hoffer, 2012). They respond to the public's concerns by shifting their attention away from negatives by focusing only on positives. This type of discourse used by the state and industries is "designed to persuade, not inform" (Hudgins & Poole, 2014, p.315). The way in which

the potential risks and benefits are portrayed in a community shapes the way the residents and community as a whole perceive the risks and benefits (Jacquet, 2014).

The differences between the federal and state governments' regulations have raised policy issues and generated conflict between those in favor of the status quo of little regulation and those in favor of expanding the regulations (Davis & Hoffer, 2012). Activists trying to expand policy may use a strategy that involves redefining the problem in a way that changes how people perceive it, so that they understand how the public's health and safety may be at stake. In addition, they try to gain the attention of the public, governmental officials, and the media. Those who do not want change, such as industry, will use careful language to direct attention away from the issue and provide reasons why there is no problem (Freudenburg & Alario, 2007).

Companies have also described some of the impacts of HVHF as a result of something other than the drilling and fracturing process, and claim the accuser's concerns are due to a lack of knowledge on the subject (Davis & Hoffer, 2012). For example, when questioned about some of the negative effects from HVHF, one oil and gas company representative replied by stating: "hydraulic fracturing is not the problem. The problem is the operation of the wells. Now, the construction of the well does play into that, but when there is a contamination to soil, air or water, it is not so much due to hydraulic fracturing as it is to some type of leak" (Hudgins & Poole, 2014, p.315). The companies try to blame accidents on the operation of the well pad, cracks in the concrete, or poor construction that caused leaks, trying to separate them as completely different activities (Hudgins & Poole, 2014).

Some scholars bring a proscriptive element to their work, arguing that community meetings and presentations of HVHF must extend beyond simply explaining the process. These scholars reason that they should also include the social, environmental, and economic aspects associated with HVHF and include topics of equality, ideals, and morals that help shape perceptions (Boudet et al., 2014; Wester-Herber, 2004). Others claim that open and honest communication among community leaders, government agencies, organization, and the industry is necessary to improve a reliable understanding of the benefits and risks associated with HVHF, increase trust, and alleviate some of the misconceptions held by residents (Theodori, 2009).

Conclusion

The rapid expansion of HVHF in the United States has raised concerns about the potential effects to communities, the economy, and ecological health. The benefits and risks associated with HVHF vary greatly between communities due to differences in size, location and geologic characteristics. Furthermore, stakeholder perceptions of these benefits and risks also vary among community characteristics or differing levels of HVHF activity. The lack of standard federal regulations and the close working relationship between regulatory agencies and the industry has raised important public policy questions. Understanding stakeholder perceptions is an important step in understanding how community perceptions are formed and how to better inform the public about both the benefits and risks associated with HVHF.

Chapter 3: High-Volume Hydraulic Fracturing in Michigan

The above literature review presents the benefits, risks, public perceptions, prevailing discourses, and the influences of politics and the media associated with HVHF. This literature informed the foundation of the coding scheme for the analysis of both media content and interview responses in this thesis. This section provides a brief overview of Michigan's history with the industry, a description of Crawford County and Barry County, and justification of why these two counties provide comparable samples for this study.

Since 1952, more than 12,000 conventional wells have been drilled in the State of Michigan (MDEQ, 2013a). The first HVHF well to successfully produce in Michigan is located in Kalkaska County (Kalkaska County borders the west side of Crawford County). The HVHF well began producing natural gas from the Utica-Collingwood formation in 2011 (FARWatershed & respectmyplanet, 2014). As of December 2014, Michigan had thirteen producing HVHF wells, eleven HVHF wells with the drilling phase complete, 28 HVHF active permits, two HVHF active applications, and five HVHF completed wells (refer to Figure 3 in Appendix A to view a HVHF activity map) (MDEQ, 2014). Encana Oil and Gas USA recently divested all of their wells and leases to Marathon Oil Company (Smith, 2014). Increased activity of HVHF in the State has spurred the formation of citizen groups, creation of petitions, lawsuits, and protests. For example, a number of protests have taken places at public land mineral lease auctions around the state. The Committee to Ban Fracking in Michigan offers another example. This committee formed in 2012 to start a statewide ballot petition to ban HVHF and its wastes in the State of Michigan.

Crawford County

Crawford County is located in the north-central portion of Michigan's Lower Peninsula (see Figure 1 in Appendix A). The county contains six townships and the City of Grayling, which is the county seat (Northeast Michigan Council of Governments [NEMCOG], 2014). The 2010 county population was 14,704. The total land area of the county is 556.28 square miles, with a population density of 25.3 people per square mile (US Census Bureau, 2014). About 70% of Crawford County's land area is publically owned lands (NEMCOG, 2014). The county's natural landscape and rural character allow for a variety of recreational activities, such as fishing, hunting, snowmobiling, and boating, which generate income for the local economy.

The Au Sable River flows through Crawford County and represents a vital part of the community, economy, and the HVHF debate. The Au Sable River starts north of the city of Grayling where the Kolke Creek and Bradford Creek join. It then runs southward through the city of Grayling, turns eastward flowing through Huron National Forest, and finally drains into Lake Huron. The mainstream portion of the river is referred to as the "Holy Waters" and was designated as an "artificial flies-only and no-kill" area in 1988. The river contains many different branches, but the "Holy Waters" is the main stream of the river ("Great Rivers", n.d.; Huron Pines Conservation, 2014). Another important part of Crawford County's identity is Camp Grayling. As the largest military installation east of the Mississippi River and largest National Guard training site, Camp Grayling covers a large portion of the county's land area, provides many jobs to the area, and contributes to the local economy (NEMCOG, 2014).

Marathon Oil Corporation owns and operates the HVHF well, State Beaver Creek 1-23 HD1, in Crawford County, located in Beaver Creek Township (MDEQ, 2014). Construction of the State Beaver Creek well began in November 2012. Once the drilling phase was complete in February 2013, the well began producing (MDEQ, 2013b). The well required 15,810,735 gallons of water to complete. The State Beaver Creek is still producing natural gas from the Utica-Collingwood formation and is Michigan's largest producing well (FARWatershed & respectmyplanet, 2014; MDEQ, 2014).

Barry County

Barry County is located in the southwest portion of Michigan's Lower Peninsula (see Figure 1 in Appendix A). The county is a quiet, rural area situated between three metropolitan areas: Grand Rapids, Lansing, and Kalamazoo/Battle Creek. The county contains 16 townships and the City of Hastings, which is the county seat (Budget, 2013). The 2010 county population was 59,173. The total land area was 559 square miles, with a population density of 106 people per square mile (Budget, 2013; US Census Bureau, 2014). Less than 10% of the land area is public land (Barry County Equalization Department, personal communication, February 13, 2015).

Barry County is characterized by its beautiful landscape, with many natural areas, abundant farmland, and numerous lakes, rivers, and wetlands (Barry County, 2014). The State of Michigan owns two significant public land areas, the Yankee Springs Recreation Area and the Barry State Game Area, which provide 22,000 acres of wildlife habitat and public space for recreation. The Barry State Game Area contains the headwaters to the Kalamazoo River Watershed and the Grand River Watershed (the longest watershed in

the State) (Southwest Michigan Land Conservancy, n.d.). The county's lakes, parks, recreation areas, and campgrounds draw in a large number of tourists in the summer.

No HVHF wells have been drilled in Barry County, but there have been many oil and gas leases signed and so there is the potential for it to come. Barry County has a history with the oil and gas industry, as there are 26 conventional oil wells, three natural gas storage wells, and one brine disposal well drilled in the county (Mitchell, 2015). The MDNR's 2012 state auction leased some mineral rights under portions of the Yankee Springs Recreation Area and Barry State Game Area to two oil and gas companies. In addition, many private landowners in Barry County have signed oil and gas leases. These leases are scattered in various locations around the county.

Justification of the Case Study Counties Comparability

Crawford County and Barry County were primarily chosen due to the difference in levels of HVHF activity between them. Both counties share histories with extractive industries, but Crawford County has a HVHF well and Barry County does not have a HVHF well. Even though Crawford County only has one well, all of the interview stakeholders were aware of the well. The presence and awareness of the HVHF well in Crawford County and the lack of a HVHF well but similar awareness of the potential for HVHF in Barry County were the factors of interest for comparing these two counties. The case study counties also share similar characteristics. The counties of Crawford and Barry are both characterized as rural counties, with fewer persons per square mile than the Michigan average of 175 people per square mile (U.S. Census Bureau, 2014). These counties rely heavily on recreational tourism for their economic well being. The counties

of Crawford and Barry contain predominantly Caucasian, aging populations, and shared conservative voting choices. Barry County residents have slightly higher income levels, marginally lower unemployment and poverty, and the county is more populated than Crawford County (see Table 2 to view characteristics of the case study counties).

Table 2: *Characteristics of the Case Study Counties*

Characteristics	Crawford County	Barry County
Total Population (2012)	14,704	59,173
Percent Population Change (April 2012-July 2013)	-1.2%	-0.1%
Population Density (2012)	25.3 people per square mile	106 people per square mile
Median Age	47.5 years old	41.9 years old
Percent White Alone (2013)	97.0%	97.2%
High School Graduate or Higher (percent of individuals aged 25 years or older; 2009-2013)	85.4%	91.1%
Bachelor's Degree or Higher (percent of individuals aged 25 years or older; 2009-2013)	15.2%	17.7%
Median Household Income (2009-2013)	$40,295	$52,186
Unemployment Rate (2013)	10.7%	6.9%
Percent of Individuals Below the Poverty Line (2009-2013)	16.8%	11.7%
Voting Choice (1998-present)	Predominantly Republican	Predominantly Republican

Note: Sources: (Budget, 2013; The Library of Congress, n.d.; US Census Bureau, 2014).

Chapter 4: Methodology

This project is guided by a grounded theory methodology (Charmaz, 2006). The grounded theory approach provides guidelines for researchers in data collection and data analysis (Corbin & Strauss, 1990). The goal of using this methodology is to improve theory on public perceptions of HVHF. Corbin and Strauss (1990) recommend that researchers collect data from any source that will provide useful information or important insight for their study. This study utilized a variety of data sources, including academic qualitative and quantitative sources, government sources, and popular media sources. The coding scheme used for the popular media content and the interviews was developed based on the key findings from the literature review. New codes emerged during the coding process of the media content, which were added accordingly, and used to analyze interview data.

Strauss & Corbin (1990) recommend theoretical sampling until saturation is reached. Potential interviewees were identified using theoretical sampling, which focused on finding individuals with the potential to provide new insights or perspectives. Sampling continued until interview provided consistent responses, known as reaching data saturation. The coding phase involved organizing the data, identifying the key themes and topics, and aggregating the information. The findings presented in tables are reported using percentages to standardize across the different sample sizes. Due to the lack of random sampling and the small sample size of this study, no statistical analysis was included.

Content Analysis

This study includes a content analysis, which identifies and compares the HVHF discourses, key themes, and perceptions by analyzing various popular media sources. The analysis involved categorizing the sources according to their publication type (see categories in Table 3) and using the themes identified in the academic literature on public perceptions of HVHF to code the discourse in each article. The themes included in the coding scheme are: the benefits of HVHF; the risks of HVHF; discussion of the land type (e.g. private or public) on which HVHF takes place; reactions or influences on the community and/or the natural environment; federal, state, and local regulations; public awareness; public response; the company or companies active in the county; the decision-making processes; background information about each county; and predictions about the county's future relationship with the natural gas industry.

The content analysis consisted of the collection and review of 63 popular sources, collected and analyzed during the time period from April 2014 to January 2015. The preliminary analysis of public perceptions of HVHF was completed before analyzing interviews. Sources include national news articles, state news articles, local news articles, letters to the editor, blogs, websites, articles, and reports. The publication dates of these sources range from April 1998 to January 2015**.** The timeframe of these publications covers dates prior to any HVHF operations in Michigan up to current publications. This timeframe also encompasses years before the general public was very aware of HVHF up until the present level of public awareness of HVHF. The media content included in the analysis was found through:

- Google searches regarding HVHF in Michigan, Crawford and Barry Counties
- Searching the counties' local newspapers' websites with key words such as fracking, hydraulic fracturing, high-volume hydraulic fracturing, natural gas, mineral leases, lease sale and the names of companies active in each county
- Searching topics or organizations mentioned in articles and on Facebook groups such as the West Michigan Environmental Action Council, Committee to Ban Fracking in Michigan, Food & Water Watch, and the Michigan Oil and Gas Association
- Following links on websites

The searches resulted in a sample of 39 news articles, 6 sources from pro oil and gas organizations, 13 sources from environmental or grassroots organizations, and 5 federal and state government sources, for a total of 63 analyzed content sources (see Table 3 for list of media sources).

The first step of the analysis involved categorization of the media content, as shown in Table 3. Once organized into these categories, the academic literature guided the coding scheme used to formally analyze each of the sources. The coding process determined the presence of shared themes, concepts, use of language, and perceptions about HVHF. These common themes were then analyzed to better understand the meaning and importance of the data.

Table 3: *Popular Media Content Analyzed*

Popular Media Categories	Names of Sources
National News Articles (8)	*Grist* (1), *New York Times* (2), *ProPublica* (1), *Upworthy* (1), *USA Today* (1), *Reuters* (1), and *SourceWatch* (1)
State News Articles reporting on the state, both Crawford and Barry Counties, or other counties in the state (13)	*Mlive (Michigan Live)* (4), *Michigan Radio* (3), *Great Lakes Echo* (1), *In These Times* (1), *Energy In Depth* (1), *Grand Haven Tribune* (1), Letter (1), and *Gongwer Michigan* (1).
State News Articles reporting on Crawford County (3)	*Mlive* (3)
State News Articles reporting on Barry County (3)	*Mlive* (3)
Local and Regional Newspapers that report on Crawford County (8)	*Avalanche* (4), *Environmental News* (1), *Topix* (1), *Tri-City Times* (1), and the *9&10 News (1).*
Local and Regional Newspapers that report on Barry County (4)	*The Hastings Banner* (2), *Fox17 West Michigan* (1), and the *Rapidian* (1).
Organization Publications, including both environmental organizations and oil and gas development organizations (19)	*Earthworks* (1), *Michigan Land Air and Water Defense* (2)*, West Michigan Environmental Action Council* (2), *Southwest Michigan Land Conservancy* (1), *Anglers of the Au Sable* (3), *Fracklist* (1), *Committee to Ban Fracking in Michigan* (2), *Keep Tap Water Safe* (1), *Energy In Depth Michigan* (2), *Drillinginfo* (2), and *Michigan Oil and Gas Association* (2).
Government, including federal and state (5)	EPA (1), Michigan DEQ (2), Michigan DNR (1), and the U.S. Congress (1)

Note: The numbers in parenthesis following each source represent the total number of articles, reports, etc. reviewed from that source.

The national news articles and state government publications collected were analyzed first to get an initial understanding of key themes, discourses, and perceptions associated with HVHF nationwide. The state news articles were divided into the following three groups: 1) reports on the state or on townships and counties other than Crawford and Barry counties; 2) reports on Crawford County; 3) reports on Barry County. In order to get more insight specific to the State of Michigan, the next set of content analyzed was the first group of state news articles, state government publications, and publications regarding Michigan. Categorizing the national reports separately from the state reports allowed for a broad understanding and then a more localized understanding of these topics and activities.

The next step of the analysis involved reviewing the media content specific to each county. Sources reporting on Crawford County were analyzed separately from those reporting on Barry County. Conducting the content analysis in this way allowed for inferences to be made about the community's perceptions in each county and how they are similar and different, providing preliminary insight and hypothesis testing. The hypothesis was then explored through interviews with key stakeholders and the analysis of the interview data. The coding scheme used for both the content analysis and interviews was modified in response to the content analysis in order to include more specific potential codes to provide a more refined analysis of the interview data.

Interviews

This study includes a total of 31 semi-structured interviews, thirteen interviews in Crawford County, sixteen interviews in Barry County, and two interviews with

individuals knowledgeable about HVHF across Michigan and in both of the case study counties. These interviews took place between November 2014 and February 2015. These interviews were with public officials and leaders of organizations or businesses. (Table 4 lists positions of stakeholders interviewed). The particular organizations, agencies, businesses, and officials were chosen because of their positions as representatives of residents, their role as decision-makers, their involvement in HVHF discussions, and their knowledge about the positive and negative changes that have or may take place in these counties. Participants were asked to think more broadly about their communities rather than just about themselves and specifically asked about perceptions, opinions, and awareness among residents of their communities (refer to Appendix B to review a copy of the interview questions).

Table 4: *Number of Stakeholders Interviewed by Position or Affiliation*

Stakeholder Positions	Crawford County	Barry County	Michigan
Business Community	1	1	0
Elected Official	4	6	0
Government Department	2	2	0
Oil and Gas Industry	0	1	1
Media	2	2	0
Organization	4	4	1

This study received approval for exemption for Michigan Technological University's Human Subjects Research Board. The interview participants were identified through Internet searches and snowball sampling. They were contacted by email or phone. They were informed of the study's purpose and that the interview would be

completely confidential. To maintain confidentiality, names have been changed to pseudonyms throughout my notes and in this thesis. In addition, stakeholders were grouped into two broad categories, government and non-government stakeholders, to reflect their position without revealing their identities. Information has also been reported here in a way that maintains the confidentiality of individual respondents and their affiliations.

Eight interviews were conducted in-person and 23 interviews were conducted over the phone. Participants were asked about their experiences working/volunteering with their specific affiliation; about their communities and things that relate to how the presence/potential presence of HVHF has or might affect them; what they perceive as benefits of HVHF; what they perceive as risks of HVHF; any changes, impacts, or responses from themselves, the community, the natural environment, or their affiliated organization, business, or position; about the decision-making process and to what extent they feel their opinions on HVHF are heard; community residents opinions and level of awareness of HVHF; and what they would like to see for the future of their community (refer to Appendix B for a copy of the interview questions). Data analysis of the interviews consisted of recording, note taking, and coding each interview according to the coding scheme developed from the literature review and refined through the content analysis. The coded interviews in Crawford County and Barry County were then organized and summarized separately.

Chapter 5: Research Results

This section presents the findings from the content analysis and interview analysis. The content analysis provided a broad insight into the key themes, discourses, and perceptions of HVHF, which were then analyzed with those that emerged from the interviews. The results of the interview analysis reveal similarities and differences between the case study counties. The case study counties differed primarily in: (1) the number of benefits and risk identified, as Crawford County stakeholders identified 25 benefits and 58 risks while Barry County stakeholders identified 19 benefits and 79 risks; (2) what they perceived as the primary benefit of HVHF, as Crawford County stakeholders identified jobs and increases economic revenue/growth while Barry County stakeholders identified revenue to the state and private landowners and increases economic revenue/growth; (3) in their perceptions of HVHF in their county, as stakeholders in Crawford County reported mostly divided or apathetic opinions of HVHF while stakeholders in Barry County reported mostly divided or anti-HVHF opinions;[44] (4) in their awareness levels of HVHF; and (5) in their level of involvement in discussions of ordinances, educational meetings, and participation in organizations, as fewer stakeholders in Crawford County described townships or groups discussing ordinances than in Barry County. Also, only one new group formed in Crawford County in response to HVHF, whereas four new groups formed in Barry County.

[4] Half of the respondents reported divided opinions, while the other half reported apathetic opinions. The use of the term "divided" refers to reports that about half of the residents in the county are for fracking and about half of the residents in the county are against fracking.

The case study counties were similar in: (1) the perception that the large use of freshwater/large water withdrawals and risk of surface water, groundwater, or drinking water contamination as the primary risks of HVHF; (2) desire for more local authority to regulate HVHF in their communities; (3) stakeholders in both case study counties reported divided perceptions within among community members; (4) reports of more personal or work time, resources, and involvement direct toward the topic of HVHF; (5) opinions of the land type and location where HVHF occurs, as the slight majority of stakeholders in both case study counties reported no difference in regards to the type of land HVHF occurs on and five stakeholders in each county reporting it is the location of the well that makes a difference.

The results indicate the following shared themes of the content analysis and interview analysis: (1) the state holds all the authority to regulate HVHF, leaving local governments with no power over HVHF within their communities, (2) as the governing body at the state level with authority to regulate, the MDEQ needs to improve their HVHF regulations, (3) the perception that "fracking" has been done for many years in Michigan with little or no distinction between the differences between conventional and unconventional wells, and (4) concerns over the large use of freshwater and potential for water contamination. This fourth theme supports the hypothesis that expected the risks HVHF poses to water resources would be a main concern shared by respondents in both case study counties.

Content Analysis

Table 5 displays the benefits of HVHF cited by the popular media sources and Table 6 displays the risks of HVHF cited by the popular media sources. The popular media sources that either support or refute this study's hypothesis are presented next, followed by a review of the key themes that emerged. Appendix C contains a more detailed summary of the analysis of the popular media content.

Table 5: *Socioeconomic and Ecological Benefits of HVHF Cited in the Analyzed Content*

Socioeconomic Benefits	Number of times cited	Percent
Jobs	13	18.6%
Revenue to the state and private landowners	13	18.6%
Increases economic revenue/Growth/Reviving industry	8	11.4%
Large reserves in U.S./Abundant supply/Reliable	7	10%
Energy security/Energy independence	7	10%
Increased U.S. production/Ability to produce formations previously unattainable	6	8.6%
Reduced energy costs/Affordable fuel	6	8.6%
Ecological Benefits	Number of times cited	Percent
Reduced CO_2 emissions/Cleaner burning fuel than coal/Clean fuel	5	7.1%
Step toward increased use of clean energy	3	4.3%
Decreases total number of wells that need to be drilled/Reduces surface development	2	2.9%

Note: The number of times cited row reflects the total number of times each benefit was cited. The percentage reflects the number of times each benefit was cited out of the total number of benefits cited (N=70).

Table 6: *Socioeconomic and Ecological Risks of HVHF Cited in the Analyzed Content*

Socioeconomic Risks	Number of times cited	Percent
Harms human health/Reduced quality of life	14	8.3%
Decreases property values/Property rights issues	9	5.4%
Changed community/Cultural/Scenery/ Potential for social and environmental justice issues	7	4.2%
Noise pollution/Light pollution/Flares	7	4.2%
Truck traffic/Road damage	6	3.6%
Potential to reduce economic viability/local businesses, tourism, and recreation	5	3%
Chemical non-disclosure	3	1.8%
Ecological Risks	**Number of times cited**	**Percent**
Large use of freshwater/Large water withdrawals	26	15.5%
Risk of surface water, groundwater, drinking water contamination	20	11.9%
Use of chemicals and additives in HVHF fluid/Disposal of chemicals, drill cuttings, and drilling muds	17	10.1%
Flowback/Wastewater storage and disposal	12	7.1%
Ecological health/Environmental concerns	12	7.1%
Surface spills/Underground leaks and migration of gas and/or chemicals	11	6.5%
Air pollution/Contribution to climate change	9	5.4%
Changed landscape/New Construction/Fragmentation	7	4.2%
Potential for earthquakes	3	1.8%

Note: The number of times cited reflects the total number of times each risk was cited. The percent reflects the number of times cited out of the total number of risks cited (N=168).

Benefits Identified by Popular Media Sources

The content analysis refuted part of this study's hypothesis that predicted increased U.S. energy independence and reduced CO_2 emissions would be the most commonly identified benefits of HVHF. Seven of the 63 popular media sources identified increased U.S. energy independence as a benefit and five of the 63 sources identified reduced CO_2 emissions as a benefit of HVHF. Rather, the primary benefits that emerged from the content analysis were jobs and revenue to state and private landowners (each identified by thirteen of the 63 sources).

According to the Natural Gas Subcommittee report discussed in one article, "increasing Michigan's extraction, production, & transportation of natural gas will create 'thousands of energy jobs throughout our state' which would 'generate $2 billion in economic activity, making Michigan a key producer'" (Lesert, 2013). However, another article cited the Headwaters Institute's study of oil and gas developments, which reported strong initial community benefits accompanying new developments, such as increased employment and income, but then followed by decline. Long-term community impacts, such as reduced income, increased crime rates, and a decline in education rates, were found to greatly outweigh the initial benefits (as cited in Fracklist, 2014). In addition, one article noted that none of the workers who installed a pipeline for the HVHF well in Crawford County were from Michigan (Minolli, 2014).

The state receives income from the following: the bonus payment paid by the lessee to purchase a lease, the rent fees the lessee pays for the number of acres leased, and from royalty payments for wells that produce. The revenue the state gains from these payments must be put into the Michigan State Parks Endowment Fund and the Game and

Fish Protection Trust Fund. By leasing state-owned oil and gas rights, the State of Michigan has grossed a combined total over $750 million dollars over the last 10 fiscal years (MDNR, n.d.). One article reported the results of a poll of local government leaders, conducted by the University of Michigan, which found that 43% of the respondents stated income for private landowners as the primary reason for encouraging HVHF developments (Ivacko & Horner, 2014).

Risks Identified by Popular Media Sources

The content analysis supported part of this study's hypothesis that predicted risks associated with the large use of freshwater and potential for water contamination would be the primary benefits identified. 26 of the 63 popular sources identified the large use of freshwater/large water withdrawals as a risk. 20 of the 63 popular sources identified risks of surface water, groundwater, and drinking water contamination associated with HVHF activities.

One article reported the University of Michigan's poll of local government leaders, which revealed that the risks HVHF poses to water resources was a concern shared by 57% of respondents (Ivacko & Horner, 2014). Tom Baird, first vice president of the Anglers of the Au Sable, stated: "the big issue is water use. They're pulling fresh water from nearby aquifers to the surface. That causes a drawdown of the aquifer, and can have an adverse effect on streams and rivers and their flow" (Wheeler, 2014). One of the articles wrote about the well in Kalkaska County, Michigan that required 21 million gallons of water to complete and also mentioned the MDEQ has received permit applications requesting permission to use up to 35 million gallons of water per well

(Rankin, 2013). For example, the five permitted wells in Michigan (at the time of the blog post) were estimated to use a combined total of approximately 132 million gallons of freshwater (Kozma, 2014). Bill Duley, a MDEQ geologist, explained that the MDEQ does not approve a permit if the proposed water withdrawals will harm the aquifer or nearby waters. He further explained: "when you burn natural gas (methane), you create carbon dioxide and water, which, will eventually return to the water cycle as rain" (Rankin, 2013). Bill Duley's explanation did not ease Rita Chapman's concerns, the Beyond Natural Gas Program Coordinator for Michigan, who responded: "the problem is that water does not go back into the aquifer it came from, as rain, it ends up somewhere else" (Rankin, 2013).

The other major concern in addition to water use is with the additives used in the fracturing fluids, which can include sands, chemicals, biocides, acids, and lubricants. Some of the chemicals are carcinogenic, hormone disruptors, and harm reproductive health. Furthermore, the water can return with additional components like mercury, arsenic, or radioactivity (American Rivers, 2011; FARwatershed, n.d.;Kozma, 2014). One article reported the findings from two HVHF studies. The first was Duke University's study that found water wells near HVHF sites can have methane concentrations up to 17 times higher than water wells far from HVHF sites. The second was the study done by Dr. Anthony Ingraffea, which revealed that of the wells studied, 6% -12% of the cement and steel casings leaked (as cited in Lesert, 2014).

Key Themes that Emerged from the Content Analysis

A few key themes emerged during the analysis. These key themes include: (1) jobs and revenue to state and private landowners were the primary benefits reported; (2) The large use of freshwater and risks of water contamination were the primary risks reported; (3) The state holds all the authority to regulate HVHF, leaving local governments with no power over HVHF within their communities; (4) As the current regulatory authority over HVHF activities, the MDEQ needs to improve their regulations; (5) Land use conflicts among private landowners, between the public and the state, and between private landowners and companies; (6) The claim that "fracking" has been done for many years in Michigan, but often with no description between conventional wells and unconventional wells is given. Each of these themes is discussed further in the next four paragraphs.

A commonly shared theme discussed the lack of power local governments have to make decision or regulate HVHF in their communities. Many local governments, organizations, citizens, and landowners feel powerless and frustrated that their opinions have no influence. The analysis suggested that there was more community activity and pushback in Barry County than in Crawford County. The limited local power was a key issue criticized by many of the articles, with suggestions that local governments should be given more authority in making decisions about whether or not they approve of new HVHF wells, the location of HVHF wells, and regulations of the associated activities on and off the well. Enacting zoning ordinances or police power ordinances are the only options local governments have to restrict or control HVHF in their communities, but even these powers are limited.

Zoning ordinances regulate land use and can be adopted by townships, villages, and cities (e.g. setbacks, maximum building heights, new additions). To enact a zoning ordinance, it must be part of a master plan, notices must be sent, hearings must be held, and appeals must be allowed. Police powers regulate activities and can be adopted by townships, villages, cities, and counties. Police power ordinances set regulations to protect the health, safety, and welfare of residents or property (e.g. traffic, parking, noise, health codes). To enact police power ordinances, the ordinances must be approved by a majority of the elected officials of the local government. These powers are limited in that they must not: (1) conflict with the state's statutes and (2) county ordinances override township ordinances (Schindler, 2014). In addition, counties and townships are prohibited from regulating any of the "drilling, completion, or operation of oil or gas wells or other wells drilled for oil or gas purposes" and have no jurisdiction to issue "permits for the location, drilling, completion, operation or abandonment of such wells" (Zimmerman, 2015, p. 4). These powers are thus limited to things such as controlling the use of roads, truck size, lights, noise, and requiring bonds.

Another common theme that emerged during the content analysis pertains to the MDEQ's regulations and oversight of the oil and gas industry. Nine articles reported strong regulations, while nineteen articles reported weak regulations. A majority of the articles discussed the MDEQ's HVHF regulations as inadequate. In addition, some criticized the agency for collaborating too closely with the industry and for favoring the industry over the public.

Land use conflicts also emerged as a key theme, as it was cited 18 times by at least one or more article in each popular media content category. Split estate, property

rights, and public trust were all identified as issues or potential issues associated with HVHF. Public trust was the primary land use conflict identified. In addition, a few articles reported concerns of decreased property values or the possibility of banks denying mortgages or homeowners insurances for properties with a HVHF well, near a HVHF, or with mineral leases.

The final key theme that emerged from the content analysis was the commonly shared claim that "fracking" has been done or regulated in Michigan for many years. This statement is often not given more explanation than that. A few articles criticized this claim as very misleading because there are differences between the traditional hydraulic fracturing done many years in Michigan and the new high-volume fracturing.

The findings from the content analysis provided insight and guidance into the analysis of interview data. The new codes that emerged during the content analysis include: revenue to the state and private landowners; reduced surface development (fewer well pads and wells need to be drilled with HVHF operations); potential to reduce economic viability/local business, tourism, and recreation; changed landscape/new construction/fragmentation; history or description of the county; claim that "fracking" has been done for many years. These codes were added to the coding scheme and also used for the interviews. The four key themes described above were consistent with the key themes identified in the interview analysis. The limited authority held by local governments and the commonly stated claim that "fracking" has been done for a long time in Michigan with little or no description between the two technologies were unexpected. Assessing the findings of the content analysis prior to analyzing interview

data provided a means of developing more robust theoretical explanations regarding perceptions of HVHF.

Interview Analysis

The lengths of the 31 semi-structured interviews ranged between 17 minutes and 87 minutes, but the majority lasted between 25 and 40 minutes. Table 7, Table 8, and Table 9 report the subjects, benefits, and risks mentioned by the stakeholders. The analysis revealed similarities and differences between the case study counties regarding perceptions of HVHF in their county. The stakeholders in the case study counties were similar in what they identified as the primary risk of HVHF, a shared desire for more local authority, and reports of divided perceptions of HVHF within the communities. The case study counties were dissimilar in what they identified as the primary benefit of HVHF, in their perceptions of HVHF, and level of participation in discussions of ordinances and number of educational meetings. In addition, Crawford County stakeholders reported a larger number of benefits and slightly fewer risks than Barry County stakeholders. Based on the content analysis, this thesis predicts that government stakeholders will perceive more benefits of HVHF, report spending more time on this topic, and use a different discourse when describing HVHF than non-government stakeholders. Therefore, responses are presented here as stated by government or non-government stakeholders, according to their positions and affiliations.

Table 7: *Frequency of Subjects Mentioned by Interview Participants*

	Crawford County	Barry County	Michigan
Benefits			
Socioeconomic	23	19	4
Ecological	2	0	2
Risks			
Socioeconomic	24	27	4
Ecological	34	52	2
Public or Private Land/Land Use			
No difference	7	9	1
Difference	4	2	1
Land Use Conflicts	4	7	1
Changes, impacts, responses			
None so far	2	8	0
Meetings	5	3	2
More time, resources, involvement	16	13	2
Recreation/tourism	5	6	2
Regulations			
Exemptions	2	2	1
Strong	2	2	1
Lacking	2	4	1
Public Opinions/ Awareness			
More support	1	0	0
More against	1	6	0
50/50 opinion	6	7	1
Don't care/apathy	3	2	0
Awareness high	2	1	1
Awareness low	4	9	0
50/50 awareness	2	2	1
Media Influences			
Documentary or Media Attention	5	3	1
Industry/ Company			
Positive	2	1	1
Negative	4	5	0
Decision-Making			
State	7	11	2
Local governments no authority	5	8	1
Ordinances or zoning	3	9	2
Quiet decisions	3	0	0
Corruption	2	3	0
Background of County			
Fracking done long time in MI	4	1	2
HVHF is a new technique	3	4	2
Recreational tourism economy	6	11	1
Future of County			
Stay same	1	3	--
Reduce	1	7	--
Increase	7	1	--

Note: No data where indicated due to inability to separate the counties. See written analysis.

Table 8: *Percent of Times Each Benefit was Mentioned by Interview Participants*

Socioeconomic Benefits	Crawford County	Barry County	Michigan
Jobs	46.2%	12.5%	50%
Revenue to the state and private landowners	30.8%	37.5%	50%
Increases economic revenue/Growth	46.2%	37.5%	100%
Large reserves in U.S./Abundant supply/Reliable	7.7%	0%	0%
Energy security/Energy independence	15.4%	6.3%	0%
Increased U.S. production/Ability to produce formations previously unattainable	15.4%	6.3%	0%
Reduced energy costs/Affordable fuel	15.4%	12.5%	0%
Ecological Benefits			
Reduced CO_2 emissions/Cleaner fuel	15.4%	0%	0%
Step toward increased use of clean energy	0%	0%	0%
Decreases total number of wells that need to be drilled/Reduces surface development	0%	0%	100%

Note: Crawford County (N=13); Barry County (N=16), and Michigan (N=2)

Table 9: *Percent of Times Each Risk was Mentioned by Interview Participants*

Socioeconomic Risks	Crawford County	Barry County	Michigan
Harms human health and safety/Reduced quality of life	7.7%	18.8%	50%
Decreases property values/Property rights issues	15.4%	25%	0%
Changed community/Cultural/Scenery/ Potential for social and environmental justice issues	23.1%	18.8%	50%
Noise pollution/Light pollution/Flares	30.8%	25%	50%
Truck traffic/Road damage	61.5%	37.5%	100%
Potential to reduce economic viability/local businesses, tourism, and recreation	23.1%	37.5%	50%
Chemical non-disclosure	30.8%	12.5%	50%
Ecological Risks			
Large use of freshwater/Large water withdrawals	84.6%	68.8%	50%
Risk of surface water, groundwater, drinking water contamination	69.2%	68.8%	50%
Use of chemicals and additives in HVHF fluid/Disposal of chemicals, drill cuttings, and drilling muds	23.1%	18.8%	0%
Flowback/Wastewater storage and disposal	23.1%	31.3%	0%
Ecological health/Environmental concerns	7.7%	31.3%	0%
Surface spills/Underground leaks and migration of gas and/or chemicals	7.7%	37.5%	0%
Air pollution/Contribution to climate change	15.4%	31.3%	0%
Changed landscape/New Construction/Fragmentation	23.1%	25%	0%
Potential for earthquakes	15.4%	12.5%	0%

Note: Crawford County (N=13); Barry County (N=16), and Michigan (N=2)

Crawford County Interview Findings

The most commonly perceived benefits of HVHF among the thirteen respondents in Crawford County were: (1) jobs and (2) increases economic revenue/growth (both identified by 6) (Refer to Table 8 for list of benefits identified). Crawford County was described as a poor county with few employment opportunities by four of the participants. Someone working for a state government department and a state-level respondent said that the jobs created by HVHF are well paying, career jobs. However, even the benefit of jobs was complicated by negative perceptions of those jobs, as four respondents questioned how many new jobs would actually be created in the county and the duration of those jobs (e.g. suggesting that these were short-term jobs). Two individuals (non-government) shared that county residents are desperate for more jobs and money, thus are willing to accept new industries even if they will only provide temporary jobs. Another non-government respondent who has talked with the industry reported that no new jobs have been created in Crawford County from HVHF.

Four of the interview participants perceived the increase in economic revenue/growth and revenue to the state from the HVHF well as very minor benefits. Michael (government respondent) does not think there is a lot of trickle down effect to the broader community, explaining: “drilling companies like to take care of themselves. They have their own living areas, eating areas, they try to somewhat isolate themselves from the community anyways. I think the economic advantage to the community is minor.” Two government respondents said they were unaware of any portion of the taxes, lease revenue, or royalties being shared with the county. Although stakeholders identified

these two benefits most frequently, they also seemed to question how much of a positive impact they have.

The most commonly perceived risks of HVHF in Crawford County are: large use of freshwater/large water withdrawals (identified by 11), risk of surface water, groundwater, or drinking water contamination (identified by 9), and truck traffic/road damage (identified by 8) (Refer to Table 9 to see list of risks identified). A non-government respondent, Walter, described HVHF as a "water destroyer." Doug, another non-government respondent, stated that "fracking in Michigan requires massive amounts of water…..it's the new fracking on steroids in Michigan."

Five respondents in Crawford County and one state-level respondent described the county's strong natural resource economy that relies heavily on recreational tourism and is fragile. Keith stated that "tourism is our lifeblood" and someone in a non-governmental position said that the Au Sable River is the area's economic lifeblood. The Au Sable River was mentioned by seven of the thirteen Crawford County respondents and one of the two Michigan respondents, all of which raised concerns of how HVHF might impact the water quality or water quantity of the river. The river was described by four interview participants as a world-class trout fishery and often considered the best trout fishery east of the Mississippi. Bryan shared how the Au Sable River provides a renewable source of income to the county: "we have to have our water and we have to think long-term...and the river keeps this town going, no doubt." Three Crawford County interview participants and one state-level respondent explained that if a large enough volume of water is withdrawn fast enough, it can have an adverse effect on nearby surface waters, stream flows, and on the underground streams that feed and keep the river

cold. They emphasized the need for the MDEQ to do baseline tests before approving permits; however, none think the MDEQ will. Three participants (three non-government) identified the lack of long-term studies and three participants identified the potential for negative long-term impacts. In contrast, two government respondents perceived the overall risks of having HVHF in Crawford County as fairly low.

In regards to land type, seven of the thirteen interview participants did not perceive a difference in the risk or benefits of having HVHF on different types of land (e.g. private or public). Five of these interview participants (four non-government and one government) noted that it is not the type of land that makes a difference, but the location of the well to water resources or residents. Carrie said, "I'm especially concerned with the proximity of oil and gas wells to natural rivers and their tributaries." One government respondent identified public trust concerns, and property rights and split estate situations were each identified by two non-government respondents.

Ten of the thirteen interview participants shared that the presence of the HVHF well in the county and increased attention given to HVHF has taken time or resources away from their positions, affiliated establishments, and lives to become more involved. Five interview participants mentioned meetings or presentation held in the county, and one interview participant talked about a group that formed in response to oil and gas leasing in their community. Three interview participants said it has had a minimal impact on recreation areas (snowmobile trails and hunting) near the well pad and four others were concerned about future impacts to recreation if HVHF expands or if any negative impacts occur. Three interview participants (one non-government and two government) said it has not created any impacts or changes in their positions or their township.

The most common theme regarding the decision-making process of HVHF in Crawford county is the lack of authority local governments have to make decisions about or regulate HVHF in their own county (identified by seven Crawford respondents and one state-level respondent). Keith, in a government position, remarked: "at the end of the day I think, people feel like, well you know what there's really nothing we can do about it, unfortunately." The only option local governments have is to implement moratoriums or use their zoning and police powers. Someone from the business community said a local organization has been discussing possible ordinances for the county and three respondents discussed one township in the county that is developing guidelines and discussing the possibility of implementing ordinances. One non-government respondent shared that even if local governments can get ordinances passed, companies would most likely sue, which would be a very expensive and difficult battle to fight against a rich, powerful company. Another non-government respondent said that although the local community does not have a final say in decision-making, organizations and residents hope to at least influence the decisions of HVHF in Crawford County.

Three interviewees (one non-government and two government) described decision-making as very quiet, so as to keep it out of the public eye. Keith said: "we need gas and we need oil, but there should be some cooperation and consideration between the oil companies, the state, and small municipalities," sharing a desire for more inclusion at the local level. The University of Michigan's Graham Institute's study was announced by the governor as a way to advise regulators and help them develop adequate HVHF regulations, but the DEQ formed and finalized their new rules last year before the final draft of the study came out. Carrie, a non-government respondent, remarked: "It's all a

little perplexing…one arm of government pressing ahead, not waiting for the other things the governor put into place." Carrie also feels that the public's opinions, the water advisory board's suggestions, and the MSU stream flow study findings were not given consideration before the MDEQ finalized their rules. On the other side, Tyler (government respondent) supports state regulations because the state has more experience regulating oil and gas production than local municipalities. Two respondents believe the MDEQ's regulations are strong and sufficient, two respondents believe the MDEQ's regulations are not adequate and should be improved, and two mentioned HVHF exemptions.

Crawford County residents' perceptions of HVHF are divided. Six interview participants reported that half of the residents are against HVHF and half are for HVHF. Three interview participants (one non-government and two government) reported mostly apathetic opinions of the residents, as long as it does not take place near them or their favorite recreational areas. Henry described a divided community, explaining: "most of the people that own on the river aren't from here, they're from someplace else. They want to preserve the resource. Most of the folk in town that were raised here, don't even use the river or think of the river…some do, but most don't." Interview participants were even more divided in their generalizations about awareness of HVHF among residents. Two said residents' awareness is high (two non-government), four said residents' awareness is low (one non-government and three government), two said about half are aware and half are not aware (one non-government and one government), and two respondents said community awareness is growing (two non-government). Four interview participants had a negative perception of Encana (the company who operated the HVHF

activities in the county until there divestment to Marathon in August 2014) and two interview participants had a positive perception of Encana.

Four interview participants reported that "fracking" has been done in Michigan for many years. Only two of the interviewees (two non-government) then described the differences between producing conventional natural gas from vertical wells compared with producing unconventional natural gas from horizontal wells. A non-government respondent critiqued the industry's claim that "fracking" has been done for many years, explaining the distinct differences between conventional and unconventional wells.

The slight majority of interviewees (seven of thirteen) believe Crawford County will experience an increase in HVHF activities in the next five years. Four said it will increase in the near future and three said it would increase once gases prices go back up and it becomes economically viable. Someone in a government position foresees a forced relationship, in that operations will take place in the county whether or not it is something the community desires. Walter, a non-government respondent, believes "oil and gas and fracturing in the next five years owns Northern Michigan, owns Crawford County, and all the conservation organizations will be doing is fighting the good fight and realizing they're going to get their asses kicked day after day after day." Two interviewees said that since their county produces natural gas, they would like a natural gas facility in the county and for it to be available to all residents and businesses in the county. Two participants in non-government positions both shared that if HVHF operations take place, they want it to be done safely and reasonably to reduce risks to the area's natural resources and public health.

Barry County Interview Findings

The most commonly perceived potential benefits of having HVHF in Barry County were: (1) revenue to the state and private landowners and (2) potential to increase economic revenue/growth (both identified by six) (refer to Table 8 for list of benefits identified). Someone from a government department explained that the revenue the DNR receives from leases goes into a fund to help maintain state parks and recreation areas. A representative from an oil and gas company stated: "last year we paid about $20 million dollars in landowner royalty just for the 2014 calendar year. So if you think about the impact of $20 million dollars going to individual landowners, especially in rural counties like Barry County, I can't think of any other kind of you know industry or anything else that can put that much money into that local economy" (referring to all of their oil and gas wells, not just HVHF). A non-government respondent said the additional income to private landowners from lease and royalty payments likely increases the currency circulating in the local economy.

The significance of the perceived benefits of HVHF also came with some questions, as three individuals (one non-government and two government) perceived the potential benefits as short-term benefits only and one government official perceived fairly minor benefits. Six interview participants believe the potential benefits are largely outweighed by the potential risks, with Jennifer (non-government) sharing: "I would say that there is strong factual support for the claim that any short-term economic benefits would be vastly outweighed by the harm done to existing economic enterprises in Barry County." Two stakeholders (one non-government and one government) perceived no benefits of having HVHF in Barry County.

The most commonly perceived potential risks of having HVHF in Barry County are: (1) large use of freshwater/large water withdrawals (identified by eleven) and (2) risks of surface water, groundwater, or drinking water contamination (identified by eleven) (refer to Table 9 to see identified risks). Someone in a government position explained that the biggest single risk is the "total destruction of the water" used to fracture the wells. Ten interview participants mentioned Barry County's natural resource economy, which relies heavily on recreation and tourism. Eleven of the participants noted the large quantity of water in Barry County. Jeff said there are "over 300 named lakes, a large number of regulated wetlands, full river systems, drainage systems. We have a lot of water. If anything were to happen, the potential to get into water would be quick." In contrast, two individuals in government positions perceived fairly low or no risks of HVHF; one explained his/her perception that there are many other activities that pose greater risks of water contamination than HVHF. Two non-government respondents were both concerned with the lack of long-term studies and two participants (one non-government and one government) were concerned about negative long-term impacts to the county.

The majority of interview participants (ten of sixteen) did not perceive a difference in the risks or benefits of having HVHF on different types of land (e.g. private or public). Five of these interview participants noted that it is not the type of land that makes a difference, but the location of the well (e.g. water resources, quality of habitat, near residents). Three interviewees (two non-government and one government) noted that when there is a potential for HVHF on or under public lands, it creates a larger uproar and resistance from the public. When HVHF takes place on or under private land the

landowner makes the decision, whereas on public lands the state makes the decision for the public (mentioned by two non-government respondents). Jennifer said she would like to see "more of a balance toward public interest rather than just the private interest of oil and gas exploration." Another non-government respondent believes it might be safer to have public lease contracts because the state is more experienced negotiating leases. This respondent also feels that the private landowners were taken advantage of because they were not very aware of HVHF at the time. Land use conflicts were identified by seven respondents, sharing concerns of split estate issues, public trust violations, infringement of property owners rights, and decline in property values as potential concerns.

Thirteen of the sixteen interview participants said that the large number of oil and gas leases in the county and the increased attention given to HVHF has taken time or resources away from their positions, affiliated establishments, and lives to become more involved. At least four new groups have formed in the community as a result of the potential for HVHF in the county and one organization filed a lawsuit against the state after leasing rights under public lands. Seven interview participants mentioned meetings or presentation held in the county, while five interview participants said it has not created any impacts or changes to them so far.

Participants reported mostly divided or negative perceptions of HVHF among county residents. Seven respondents said about half of the residents are for and half of the residents are against having HVHF in the county. Six respondents said the majority of the residents are against having HVHF in the county. Jordan (government) said Barry County residents "don't care to have fracking. Primarily because of the water use." Nine of fifteen respondents feel that most county residents are not very aware of the potential for

HVHF in Barry County and/or do not understand the process of HVHF well. Tim, who holds a government position, shared: "there's a significant portion of the population that doesn't really have a great understanding of all the stuff involved and all the measures that are taken to install a well." Four interviewees said awareness among residents in the county is growing and strongly believe a fewer number of landowners would have signed leases if they knew what they do now. Someone in non-government position said the private lease contracts "are drafted in an egregious manner- all benefit, all legal protection, goes to the companies. There is nothing that protects the landowners, nothing. It is shameful." This individual has heard of several landowners who signed an oil and gas lease and now regret it.

An individual from a government department said "fracking" has been done for many years in Michigan. Two respondents criticized this claim, as the HVHF technology differs from the conventional wells drilled in the past. Two stakeholders shared that the MDEQ is willing to give presentations at public meetings, but their dialogue with the public does not seem very genuine and the way they present HVHF diminishes the potential risks and fails to disclose the full details of the process, which sets up a situation for mistrust. A non-government respondent stated that: "they have a way of presenting fracking as safe to the public and diminishing risks that we all, especially now, know to be potential risks. And I think that if the DEQ and DNR and state regulatory agencies would be much more upfront about the realistic risks, their credibility with the public would be improved." The MDEQ also makes the claim that HVHF has been done safely with no reported incidents of contamination. A non-government respondent revealed that when the MDEQ says this they mean there have been no reported wellhead mishaps or

blowouts, so this statement does not include the peripheral activities associated with HVHF production or even the on-site spills. Two individuals in government positions explained that the DEQ has very strong regulations over HVHF operations, while two non-government respondents and one government respondent described the regulations as inadequate.

Five interview participants had negative perceptions of the oil and gas industry and one participant shared a positive perception of the industry. Three non-government respondents criticized the landmen's tactics in renewing or obtaining new leases with private landowners. One shared that when the landmen went to renew leases with farmers in the county who signed leases in the past when they drilled vertically they did not explain that the technique has changed. This respondent has heard about some of the older residents who own farms and renewed their oil and gas leases that are very upset and emotional because they did not know the drilling technology changed when they renewed. They feel they were taken advantage of and worry their neighbors will find out and be upset.

The most common theme in regards to decision-making is that local governments have no authority concerning HVHF in their communities (mentioned by eight). Roger, in a government position, shared that "unfortunately, it's out of local hands. We can only complain and add some road blocks." A different respondent in government shared that a strength of having regulations set at the state level rather than the local level is that the state has more expertise on oil and gas activities than local governments. In addition, another government shared that having control at the state level reduces some of the emotions and NIMBY type attitudes residents might have, but also means some

important knowledge residents have about their local communities is not taken into account. Nine participants mentioned being involved with or hearing of townships considering using their zoning and police powers to develop ordinances (e.g. restrict truck traffic on certain roads or times of the day, reduce noise pollution at certain times of day, require companies to buy bonds). Orangeville Township was mentioned in two interviews as the first township in Barry County to implement ordinances. David stated: "at local government level the only way (to prevent HVHF) is to put enough ordinances in place that its almost impossible for them (companies) to get through all of our hoops to drill." He also said that three townships in the county have sent resolutions to the county, state, and federal governments explaining they want HVHF banned in their communities. A non-government respondent said that one of the justifications to restrict local governments from regulating HVHF is because the state law requires the DEQ to foster the growth and development of the oil and gas industry. Two other respondents not in government positions said the DEQ's role by law is more to facilitate the industry and use the natural resources and less so to regulate it.

Ten of the sixteen interview participants mentioned Barry County's economy, which relies heavily on recreation and tourism. Seven of the sixteen Barry County participants and one state-level participant were concerned that the presence of HVHF and any type of negative environmental impact would greatly harm the county's economy. David, a government respondent, shared: "Barry County is an oasis…people come here for pure water and the quiet and the fresh air," and he worried that HVHF would affect that way of life. In contrast, someone from a government department suggested HVHF could draw media attention to the county and increase the number of

people who know about its beauty and opportunities, which could result in an increased number of visitors.

Most residents think the reason Barry County does not yet have HVHF is because the oil and gas formations are not expected to be very productive. Eight of the interview participants did not foresee any HVHF operations coming into the county in the next five years and four interview participants said it was too hard to predict. There is a general perception that the oil and gas companies have left the county and will not renew their lease contracts. One state-level respondent also shared that the formation in Barry County is not very productive and so he/she believes the companies will let their leases run out without renewing. A future concern shared by an elected official and someone affiliated with an organization is the potential for injection wells of flowback fluids in Barry County.

Chapter 6: Interpretation of Research Results

Respondents in Crawford County perceived a greater number of benefits and slightly fewer risks of having HVHF in their county than Barry County respondents, who perceived fewer potential benefits and a slightly greater number of risks. The case study counties also varied slightly in what they identified as the primary benefits or potential benefits of having HVHF in their county. Both counties identified increases economic revenue/growth as one of the top two primary benefits, but differed in what they identified as the other top benefit. Crawford County perceived jobs, while Barry County perceived revenue to state and private landowners as one of the tops benefits. Only two of the sixteen respondents in Barry County perceived jobs as a potential benefit. In addition, two of the thirteen respondents Crawford County identified the potential to reduce CO_2 emissions/cleaner burning fuel as benefits of HVHF, but was not identified by any respondents in Barry County. Theodori (2009) also found that perceptions of the potential negative and positive impacts associated with unconventional natural gas development vary among communities with dissimilar levels of development. For example, respondents in both counties shared more similarities in what they perceived as getting worse and differed more in what they perceived as improving from the presence of HVHF operations in their counties.

Stakeholders in both counties shared similar concerns regarding the potential impacts to water resources. Crawford County and Barry County respondents both perceived risks from the large use of freshwater/large water withdrawals and risks of surface water, groundwater, and drinking water contamination as the primary risks of having HVHF in their counties. Similarly, two other similar comparative studies in the

Barnett Shale found that the large use of freshwater was a primary concern shared by respondents in both counties with different levels of HVHF activity (Anderson & Theodori, 2009; Theodori, 2009). Furthermore, 69% of New Yorkers and Pennsylvanians aware of HVHF were concerned about HVHF impacts to water quality (Infogroup/ORC, 2010). The risks HVHF poses to water resources was also the primary concern cited in the analyzed popular media content. In addition, Crawford County and Barry County were both more concerned with the location of the well than the type of land operations take place on. The primary concern is the proximity of HVHF wells to water resources and residents

Both Crawford and Barry Counties were described as having economies that rely heavily on recreation and tourism. Respondents in both counties shared a desire to protect the water resources and natural environment of their county, as any significant impacts would negatively affect their economies. Heather (Barry County respondent) described the citizenry of Barry County as "environmentally conscious and aware," so they are concerned with any type of new activity that might impact the beauty and resources of the area. Crawford County residents were described as being more concerned about bringing jobs and money to their county, but did share concern of potential negative effects to the Au Sable River. Anthony shared: "in Crawford, people are hungry for jobs but they are also hungry not to have their water polluted. It seemed like, like while there was skepticism, that there also seemed to be a strong and understandable desire to bring jobs and stability to a county that hasn't had much of each."

Two studies recognized by stakeholders in both of the case study counties include the MSU stream flow study, mentioned eight times, and the University of Michigan study

of hydraulic fracturing in Michigan, mentioned five times. This finding suggests that stakeholders in both case study counties have a desire to know more about HVHF based off of the results from scientific studies. In addition, MSU's preliminary stream flow study revealed that there might be significant adverse effects from the water withdrawals used for HVHF on nearby surface waters. Based off of the number of stakeholders and the number of popular media articles that discussed both studies, it seems a greater understanding of HVHF and its potential effects is desired as well as for regulators to give both studies greater consideration in their decision-making.

Crawford County stakeholders reported mostly mixed awareness levels among community residents and Barry County stakeholders reported mostly low awareness levels among community residents. This paper explains this ambiguity in residents' level of awareness as largely due to the fact that Crawford County has an active well already, and therefore more residents have been exposed or educated about it. Barry County does not have an active well and it was only in 2011 with a state lease auction that HVHF discussions began in the county.

Crawford County respondents reported mostly divided or apathetic opinions of HVHF.[5] One respondent in Crawford County believed most residents were in support and one believed more were in opposition. Barry County respondents reported mostly divided or negative opinions of HVHF. None of the respondents in Barry County thought more residents were in support of HVHF. Stakeholders in both counties perceived a division

[5] Half of the respondents reported divided opinions, while the other half reported apathetic opinions. The use of the term "divided" refers to reports that about half of the residents in the county are for fracking and about half of the residents in the county are against fracking.

between the percent of residents in support and percent of residents against HVHF. Two other studies, the Boudet et al. (2014) study and the Pew Research Center (2012) study reveal a similar division in the broader American public as well. For example, Boudet et al. (2014) found that 58% of Americans were unsure whether they were in support or in opposition to the HVHF process. The fact that stakeholders in both counties reported divided perceptions among community residents in the case study counties could be due to different perceptions between non-government affiliated stakeholders and government affiliated stakeholders. The following four tables (Table 10, Table 11, Table 12, and Table 13) provide information on the relationship between stakeholder positions and perceptions of HVHF between the case study counties.

Table 10: *Percentage of Non-Government Stakeholders Mentioning Specified Benefits*

Socioeconomic Benefits	Crawford County	Barry County
Jobs	57.1%	0%
Revenue to the state and private landowners	14.2%	37.5%
Increases economic revenue/Growth	71.4%	50%
Large reserves in U.S./Abundant supply/Reliable	0%	0%
Energy security/Energy independence	14.2%	12.5%
Increased U.S. production/Ability to produce from formations previously unattainable	14.2%	0%
Reduced energy costs/Affordable fuel	28.6%	0%
Ecological Benefits		
Reduced CO_2 emissions/Cleaner fuel	0%	0%
Step toward increased use of clean energy	0%	0%
Decreases the total number of wells that need to be drilled/Reduces surface development	0%	0%

Note: Crawford County (N=7); Barry County (N=8)

Table 11: *Percentage of Government Stakeholders Mentioning Specified Benefits*

Socioeconomic Benefits	Crawford County	Barry County
Jobs	33.3%	25%
Revenue to the state and private landowners	50%	37.5%
Increases economic revenue/Growth	16.7%	25%
Large reserves in U.S./Abundant supply/Reliable	0%	0%
Energy security/Energy independence	16.7%	0%
Increased U.S. production/Ability to produce from formations previously unattainable	16.7%	12.5%
Reduced energy costs/Affordable fuel	16.7%	25%
Ecological Benefits		
Reduced CO_2 emissions/Cleaner fuel	33.3%	0%
Step toward increased use of clean energy	0%	0%
Decreases the total number of wells that need to be drilled/Reduces surface development	0%	0%

Note: Crawford County (N=6); Barry County (N=8)

Table 12: *Percentage of Non-Government Stakeholders Mentioning Specified Risks*

Socioeconomic Risks	Crawford County	Barry County
Harms human health and safety/Reduced quality of life	14.2%	37.5%
Decreases property values/Property rights issues	14.2%	25%
Changed community/Cultural/Scenery/ Potential for social and environmental justice issues	42.9%	37.5%
Noise pollution/Light pollution/Flares	28.6%	25%
Truck traffic/Road damage	71.4%	50%
Potential to reduce economic viability/local businesses, tourism, and recreation	42.9%	12.5%
Chemical non-disclosure	28.6%	25%
Ecological Risks		
Large use of freshwater/Large water withdrawals	85.7%	75%
Risk of surface water, groundwater, drinking water contamination	71.4%	62.5%
Use of chemicals and additives in HVHF fluid/Disposal of chemicals, drill cuttings, and drilling muds	28.6%	25%
Flowback/Wastewater storage and disposal	28.6%	12.5%
Ecological health/Environmental concerns	14.2%	37.5%
Surface spills/Underground leaks and migration of gas and/or chemicals	0%	37.5%
Air pollution/Contribution to climate change	28.6%	37.5%
Changed landscape/New Construction/Fragmentation	42.9%	37.5%
Potential for earthquakes	14.2%	12.5%

Note: Crawford County (N=7); Barry County (N=8)

Table 13: *Percentage of Government Stakeholders Mentioning Specified Risks*

Socioeconomic Risks	Crawford County	Barry County
Harms human health and safety/Reduced quality of life	0%	0%
Decreases property values/Property rights issues	16.7%	25%
Changed community/Cultural/Scenery/ Potential for social and environmental justice issues	0%	0%
Noise pollution/Light pollution/Flares	33.3%	25%
Truck traffic/Road damage	50%	25%
Potential to reduce economic viability/local businesses, tourism, and recreation	16.7%	12.5%
Chemical non-disclosure	33.3%	0%
Ecological Risks		
Large use of freshwater/Large water withdrawals	83.3%	62.5%
Risk of surface water, groundwater, drinking water contamination	66.7%	75%
Use of chemicals and additives in HVHF fluid/Disposal of chemicals, drill cuttings, and drilling muds	16.7%	12.5%
Flowback/Wastewater storage and disposal	16.7%	50%
Ecological health/Environmental concerns	0%	25%
Surface spills/Underground leaks and migration of gas and/or chemicals	16.7%	37.5%
Air pollution/Contribution to climate change	0%	25%
Changed landscape/New Construction/Fragmentation	0%	12.5%
Potential for earthquakes	16.7%	12.5%

Note: Crawford County (N=6); Barry County (N=8)

The difference in opinions of HVHF, with Barry County stakeholders reporting stronger negative opinions among community residents than Crawford County, refutes

this study's hypothesis that the two counties would share similar perceptions of HVHF. Two respondents, Richard and George, have been involved in HVHF discussions and have attended a number of meetings and events about HVHF held around the state. They both reported noticing differences in community perceptions of HVHF among counties with differing levels of production. Richard has noticed that counties with no oil and gas wells are more concerned when there is a potential for operations to come to their county. George explained how counties that have had oil and gas production for a while tend to have positive perceptions of HVHF, whereas counties with little experience (those with a few wells drilled but no production) tend to have more negative perceptions of HVHF. In addition to different opinions, Barry County seemed more active in forming groups, holding public education meetings, and involved in discussing possible ordinances. The extremely limited control local governments have regarding HVHF decisions and regulations in their own communities was a shared similarity by stakeholders in both counties, described as a source of frustration for local communities. One respondent said: "local governments should be doing the right thing to protect their citizens" to ensure they have sufficient protections for the air, water, and land resources of their community if HVHF comes. Although it was a concern held by stakeholders in both counties, the community of Barry County was taking a more active role in response to this. Three possible explanations exist for this difference in opinions and level of involvement by residents in the case study counties, which follow.

The first explains this difference as the result of the presence of HVHF activity in Crawford County, but not in Barry County. Like many other activities, the potential for new HVHF wells triggers strong NIMBY feelings in residents. This could be a factor as

to why Barry County is more opposed and more actively involved in discussions to try and prevent HVHF operations from coming to their county. Since they do not have any HVHF wells yet, they may feel more concerned that if it one well is drilled it will open the door for many wells to be drilled.

The second possible explanation as to why the community of Barry County appears to be more involved and active in trying to prevent HVHF from coming to their county or townships is due to the small economic and demographic differences between the two counties. Barry County has slightly higher income levels and slightly lower unemployment and poverty levels than Crawford County. This difference may highlight an environmental justice matter, since Barry County is slightly better off, and thus maybe residents can afford more resources to respond.

The third possible explanation could be the result of the combined difference in percent of public lands and available jobs. 70% of the land area in Crawford County is public land, whereas less than 10% of the land area in Barry County is public land. In addition, Crawford County was described as having few employment opportunities and has slightly higher unemployment and poverty levels than Barry County. The HVHF well in Crawford County is located on public land, but if HVHF were to come to Barry County it would likely be located on private land. In addition, there seems to be a strong desire for jobs, which may be another factor explaining why residents are more apathetic and mixed in their opinions. Residents may see HVHF as an offering a new job opportunity, even if it only offers short-term employment.

A respondent shared that the MDNR and MDEQ both go to the industry with their questions about new technologies and input on regulatory rules, sharing that the industry

has “a very beneficial and straightforward relationship with the Office of Oil, Gas, and Minerals” (George). Several interview respondents in both case study counties criticized the MDEQ for their lack of consideration of the public opinions and findings from the university studies conducted in Michigan. In addition, their conflicting role to “protect the interests from unwarranted waste of gas and oil and to foster the development of the industry along the most favorable conditions and with a view to the ultimate recovery of the maximum production of these natural products” was also described as a concern (as cited by Zimmerman, 2015).

Stakeholders in both case study counties critiqued the claim the MDEQ makes that “fracking” has been done for many years in Michigan, with either little or no explanation of the differences between conventional and unconventional wells. This issue was also prevalent in the content analysis, which was discussed in sixteen of the 63 articles. Two respondents, one from Crawford and one from Barry, also challenged the comparison the industry makes regarding water usage for HVHF. David from Barry County discussed the industry’s argument that the volume of water used in a typical HVHF well is the same as the amount of water the City of Kalamazoo uses each day, arguing in response: “well that’s right, but it goes right back into the system. We use it again. You’re pulling it out, filling it full of toxic chemicals, and injecting it down beyond the hydro-aquifers and it’s gone.” This study speculates that the MDEQ and the industry explain the process in a way to make the public perceive HVHF as something that has been done for a long time, in an attempt to diminish the publics concerns and opposition. In order to improve understanding of HVHF, honest descriptions of the technology need to be shared with the public.

The interview process led to a discussion of a copy of talking points for landmen in selling oil and gas lease rights in the Midwest that was mistakenly left behind at an establishment in one these counties. The talking points are extremely misleading. The landmen are told to stress the benefits of the additional income from the lease payment, potential royalty payments, and ability to support the U.S. in increasing its energy independence. The suggestion to emphasize U.S. energy independence does not closely coincide with the findings of this thesis, as the stakeholders in both counties and the analyzed content did not identify it as a significant benefit. The landmen are advised to try and not talk with women because they tend to care more about the environment and thus are less likely to sign right away. They are also told to avoid sharing particular topics, details, and studies with landowners. Some of the highlights follow: (1) stress that they are primarily looking for oil resources; (2) do not mention fracking. If asked, most do not know the difference between conventional and unconventional, so use this to your advantage; (3) do not tell landowners that 10-20 wells can be placed in one square mile. Do not tell them and stress that wells are spaced 40 acres or further apart; (4) do not explain that the five year lease automatically renews if the company is producing oil or gas; (5) stress that we do not use any radioactive materials. Studies have shown that HVHF activities have caused an increase in radioactivity in groundwater. Most landowners do not know that the HVHF process releases the naturally occurring radioactive sources found in the ground, so do not tell them. If asked, tell them natural radiation is always there and their activities will not change that; (6) avoid the topic of property values. Do not tell them many studies show property values decline for land with oil and gas leases on the property and some of the major banks have stopped lending

mortgages on properties with mineral lease or oil and gas leases; (7) in regards to water use, landmen are told that most private landowners will not know that the water withdrawn for the operation is sourced from the local aquifer; (8) tell undecided landowners that all of their neighbors have signed leases whether they have or not to try and sway them into signing.[6]

The highlighted talking points presented here connect back to discontents and frustrations shared by interviewed stakeholders and in the content analysis about the lack of full and honest information presented by landmen, industry, and regulators. A concern identified by a few stakeholders was that many landowners were taken advantage of into signing leases because they were not very knowledgeable about HVHF or were not told the fracturing process had changed. Michigan State University and an organization in Barry County have responded by creating their brochures with important advice and tips for private landowners, so they have a helpful resource if approached by an oil and gas landmen.

[6] Refer to: http://voicesweb.org/gas-companys-lost-landsmans-handbook-reveals-deceptive-practices-marcellus-fracing-industry to read an article reporting on a land man's handbook left at a home in Pennsylvania. The article also provides a link to a pdf of the handbook.

Conclusion

Based on a review of previous literature, it was expected that both case study counties would most commonly perceive increased U.S. energy independence and reduced CO_2 emissions as benefits of HVHF, but neither county perceived these benefits as being significant. Rather, the most commonly perceived benefits in Crawford County were 'jobs' and 'increases economic revenue/growth' and the most commonly perceived benefits in Barry County identified 'revenue to the state and private landowners' and 'increase economic revenue/growth.' The primary risks identified supported this thesis' hypothesis, as the most commonly identified risks of HVHF mentioned by stakeholders in both counties were the 'large use of freshwater/large water withdrawals' and 'risks of surface water, groundwater, and drinking water contamination.' The null hypothesis that both counties would share similar perceptions of HVHF was refuted by this study, as Barry County stakeholders reported stronger negative opinions and seemed to be more active in preventing HVHF from coming to their county. These findings indicate that counties with differing levels of HVHF activity contain dissimilar perceptions of the primary benefits, opinions of HVHF, and acceptance/resistance to HVHF, but contain similar perceptions of the primary risks of HVHF.

Two other unexpected findings from this study include: (1) the especially low significance of 'reduced CO_2 emissions/cleaner burning fuel' and 'increase U.S. energy security/energy independence' identified in the content analysis and by interviewed stakeholders, since these are two frequently promoted campaign points used by the industry; and (2) the fact that the majority of interviewees did not perceive a difference in regards to the type of land (e.g. public or private) where HVHF operations occur, as most

were more concerned about the location of the well in relation to water resources and residents.

Risks associated with the large water withdrawals used to fracture horizontal, high-volume wells and risks of water contamination were both primary concerns shared by interview participants, the analyzed content, and in the scholarly literature. Many stakeholders and popular media sources identified the need to upgrade the Water Withdrawal Assessment Tool and improved baseline studies of potential impacts in order to provide stronger protection of Michigan's water resources and public health. State regulators need to consider these calls for improvement moving forward. This theme also offers a strong framing for groups interested in opposing HVHF development, regardless of whether or not their area produces unconventional natural gas.

Two other important findings that emerged from both the content analysis and the interview analysis was first the lack of authority held by local governments, which should have more authority in the decision-making processes regarding HVHF in their communities. Second, was the commonly made statement that "fracking" has been done for many years in Michigan. This claim is often made with little or no explanation of how traditional hydraulic fracturing, which has been done for many years in the state, differs from HVHF that has only been employed since 2011 in the State. In response, this thesis recommends more open and honest communication among regulators, stakeholders, and the general public. There needs to be an increase in dialogue with the public by sharing impartial information. Furthermore, as suggested by the popular content and interviewed stakeholders, HVHF regulations need to be improved by: (1) removing federal and state exemptions as well as granting local governments more power; (2) upgrading the Water

Withdrawal Assessment Tool; (3) improving assessment of potential impacts, including cumulative impacts, that may ensue from HVHF operations; (4) increasing distance requirements to residential areas and surface waters; and (5) requiring chemical disclosure when companies apply for permits.

This thesis faced two main limitations. One limitation being that Crawford County has a larger percentage of public land area and is located much further from a metropolitan center than Barry County. Brasier et al. (2011) conducted a similar comparative study and found that community characteristics (e.g. population size, urban vs. urban, available transportation, infrastructure development) may have a stronger influence over stakeholder perceptions than their community's level of activity or history with extractive industries. Crawford and Barry Counties both have histories with extractive industries, but do have different population sizes and proximity to urban centers, which may be a contributing factor for the differences in perceptions between the case study counties. The other limitation is in regards to the small demographic differences between these two counties, as Barry County does have slightly higher income levels and slightly lower unemployment and poverty levels. This could be the reason why Barry County residents are more involved in this topic and why there are no HVHF wells in the county. The findings suggest that this study might be highlighting an environmental justice matter.

The comparative analysis carried out in this study provides an understanding of how perceptions are shaped by the presence of unconventional natural gas developments and presents the key issues and concerns shared by both case study counties. Utilizing a grounded theory approach provided valuable guidelines for gathering and analyzing data,

which allowed for a better understanding and improved theory on perceptions of HVHF. Another strength of this study involved the inclusion of both a content analysis and interview analysis, which resulted in a more effective coding scheme and robust theoretical understanding of perceptions.

This study suggests for further research on perceptions of HVHF include interviews with similar stakeholders as this study as well as interviews with the general public (e.g. government officials, non-government community leaders, and general public). This would allow for an analysis of responses by different stakeholder positions, which might provide a better understanding why there are reports of divided perceptions among community residents within a county. In response to the limitations of this study, future comparative studies should also evaluate counties with more similar socioeconomic demographics as well as dissimilar socioeconomic demographics to determine how influential these characteristics are in shaping perceptions. Furthermore, doing so would allow future researchers to determine whether different levels of HVHF activities among counties in the same state, emerges as an environmental justice issue.

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Appendix A: List of Figures

Figure 1: County Map of Michigan. Taken from: MDNR. (2015). *USGS Topographic Quadrangle Maps by County*. Retrieved from http://www.michigan.gov/dnr/1.1607.7-153-10371_14793-31264--,00.html.

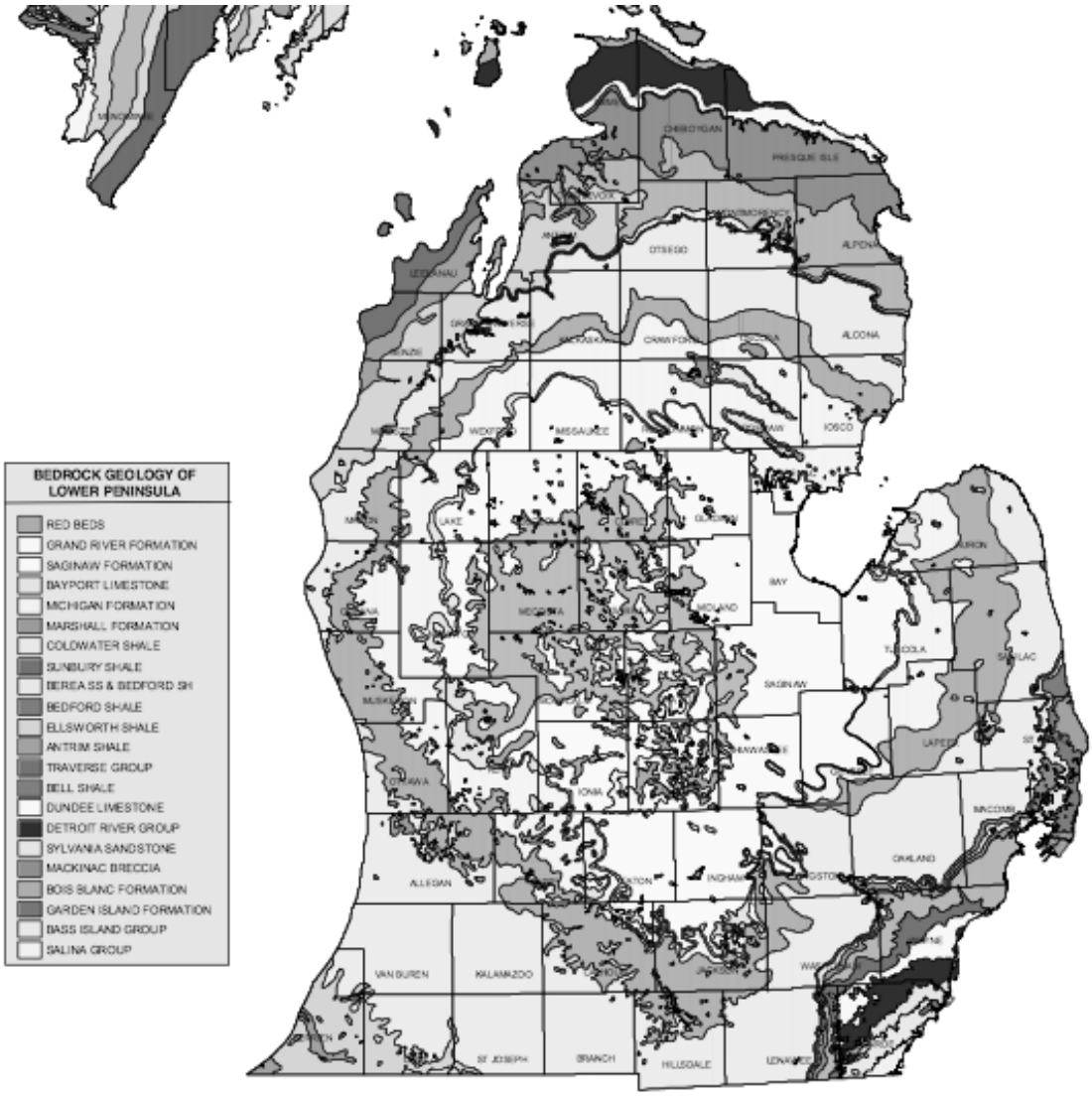

Figure 2: Bedrock Map of Michigan. Adapted from: MDEQ. (1999, November 12). *1987 Bedrock Geology of Michigan.* Retrieved from April 14, from http://www.michigan.gov/documents/deq/1897_Bedrock_Geology_Map_301466_7.pdf.

Figure 3: HVHF Activity in Michigan. Adapted from: MDEQ. (2015, March 5). *High Volume Hydraulic Fracturing Active Applications and Active Permits*. Retrieved from http://www.michigan.gov/documents/deq/hvhfwc_activity_map_new_symbols-jjv_483124_7.pdf.

Appendix B: Interview Questions

Crawford County Interview Questions

1. How long have you been involved with/working for _____?
2. Crawford County- (Do you know where in the county the hydraulic fracturing operations are occurring? Do you know whether the land is public or private?
    a. What are the benefits of having fracking on one type of land versus the other?
    b. What are the risks of having fracking on one type of land versus the other?
3. Do you know which company owns and operates the well?
    a. Do you know anything about the company?
4. Now I want to ask you specifically about your position at_____. What benefits and risks has your (organization, business, etc.) experienced by the hydraulic fracturing operations? How does fracking impact the kinds of things you do in your business/organization?
5. Now I want to ask you more generally about your county…. What would you identify as the benefits of having hydraulic fracturing in your county?
6. What would you identify as the risks of having hydraulic fracturing in your county?
7. How does hydraulic fracturing impact the kinds of things you do in your community?
8. Now I want to ask you about how decisions about hydraulic fracturing are made in your county. In what ways have community organizations, businesses, etc. been involved in decision-making regarding fracking operations/mineral leases?

a. Can you describe the successes and weaknesses of that process?

9. I want to try to connect what you said about (RISK) and about decision-making… (follow-up to what they identified as being a primary risk in #4) You identified earlier that _____ was a concern when talking the risks of fracking. Can you elaborate?
    a. What would you like to see as a next step to mitigate this issue?
10. Could you tell me, what kind of relationship you see between the natural gas industry and your county in the next 5 years?
    a. Is this the relationship you would like to see for you community? If not, why not? What would you hope for? Do you see ways to participate in making that happen?
11. Where do you get your source of news? (national, state, local, internet)
    a. How about the community?
12. If you could gage the county's feeling about hydraulic fracking, what would you generalize it to be?
13. Do you think community members are aware about the hydraulic fracking operations?
14. Township Supervisors:
    a. What is the history of the county like?
        i. History with natural gas? History with extractive industries?
        ii. Why does Crawford County have fracking?

Barry County Interview Questions

1. How long have you been involved with/working for _____?
2. Barry County- (Do you know where the mineral leases are that are owned by oil and gas companies? Do you know whether these leases are on public or private land?
    a. What are the benefits of having fracking on one type of land versus the other?
    b. What are the risks of having fracking on one type of land versus the other?
3. Do you know which company or companies have been buying mineral rights?
    a. Do you know anything about the company?
4. Now I want to ask you specifically about your position at_____. What benefits and risks has your (organization, business, etc.) experienced by the mineral lease sales and potential for hydraulic fracturing? How would hydraulic fracturing impact the kinds of things you do in your business/organization?
5. Now I want to ask you more generally about your county…. What would you identify as the benefits of having hydraulic fracturing in your county?
6. What would you identify as the risks of having hydraulic fracturing in your county?
7. How would hydraulic fracturing impact the kinds of things you do in your community?
8. Now I want to ask you about how decisions about hydraulic fracturing are made in your county. In what ways have community organizations, businesses, and the

state been involved in decision-making regarding fracking operations/mineral leases?

   a. Can you describe the successes and weaknesses of that process?

9. I want to try to connect what you said about (RISK) and about decision-making… (follow-up to what they identified as being a primary risk in #4) You identified earlier that _____ was a concern when talking the risks of fracking. Can you elaborate?

   a. What would you like to see as a next step to mitigate this issue?

10. Could you tell me what kind of relationship you see between the natural gas industry and your county in the next 5 years?

   a. Is this the relationship you would like to see for you community? If not, why not? What would you hope for? Do you see ways to participate in making that happen?

11. Where do you get your source of news? (national, state, local, internet)

   a. How about the community?

12. If you could gage the county's feeling about hydraulic fracking in the county, what would you generalize it to be?

13. Do you think community members are aware about the potential hydraulic fracking operations?

14. Township Supervisors:

   a. What is the history of the county like?

      i. History with natural gas? History with extractive industries?

      ii. Why hasn't Barry County had fracking operations yet?

Appendix C: Content Analysis

Table 14: *Subjects Mentioned by the Popular Media Content Analyzed*

	National News Articles	State News Articles	Articles on Crawford County	Articles on Barry County	Publications by Various Groups	Government Publications
Benefits	4 out of 8 50.0% Cited: 5	6 out of 16 37.5% Cited 8	3 out of 8 37.5% Cited: 5	1 out of 4 25.0% Cited 3	9 out of 19 47.4% Cited: 10	3 out of 5 60.0% Cited: 4
Risks	4 out of 8 50.0% Cited: 9	11 out of 16 68.8% Cited: 13	6 out of 8 75.0% Cited: 19	3 out of 4 75.0% Cited: 9	13 out of 19 68.4% Cited: 15	2 out of 5 40.0% Cited: 8
Private or Public Land and Land Use	3 out of 8 37.5% Cited: 2	9 out of 16 37.5% Cited: 4	3 out of 8 37.5% Cited: 2	1 out of 4 25.0% Cited: 1	5 out of 19 31.6% Cited: 4	1 out of 5 20.0% Cited: 1
Changes, Impacts, Responses	7 out of 8 87.5% Cited: 10	12 out of 16 75.0% Cited: 7	5 out of 8 62.5% Cited: 11	4 out of 4 100% Cited: 4	10 out of 19 52.6% Cited: 15	0 out of 5 0%
Regulations	4 out of 8 50.0% Cited: 3	10 out of 16 62.5% Cited: 6	5 out of 8 62.5% Cited: 5	3 out of 4 75.0% Cited: 3	11 out of 19 57.9% Cited: 5	5 out of 5 100% Cited: 4
Media Influences	0 out of 8 0%	0 out of 16 0%	2 out of 8 25.0% Cited: 1	1 out of 4 25.0% Cited: 1	2 out of 19 10.5% Cited: 3	0 out of 5 0%
Industry or Company	5 out of 8 62.5% Cited: 4	6 out of 16 37.5% Cited: 4	2 out of 8 25.0% Cited: 2	1 out of 4 25.0% Cited: 1	2 out of 19 10.5% Cited: 2	0 out of 5 0%
Decision-Making	4 out of 8 50.0% Cited: 4	7 out of 16 43.8% Cited: 4	3 out of 8 37.5% Cited: 3	4 out of 4 100% Cited: 4	6 of 19 31.6% Cited: 4	3 out of 5 60.0% Cited: 2
Description of County	0 out of 8 0%	5 out of 16 31.3% Cited: 2	2 out of 8 25.0% Cited: 2	2 out of 4 50.0% Cited: 2	5 out of 19 26.3%% Cited: 3	3 out of 5 60.0% Cited: 4
Future of County	0 out of 8 0%	2 out of 16 12.5% Cited: 3	1 out of 8 12.5% Cited: 1	0 out of 4 0%	2 out of 19 10.5% Cited: 1	0 out of 5 0%

Note: The "cited" number reflects the number of subjects cited in each category.

Table 15: *Frequency of Subjects Cited in the Popular Media Content Analyzed*

	National News	State News	Local Articles Crawford County	Local Articles Barry County	Publications by Various Groups	Government Publications
Benefits						
Socioeconomic	5	13	7	3	28	5
Ecological	1	2	0	0	4	2
Risks						
Socioeconomic	5	9	6	4	24	3
Ecological	10	26	21	12	40	9
Land Type/Use						
Split estate	1	2	0	0	1	1
Property Rights	2	1	0	0	2	0
Public trust	0	3	1	1	3	0
Changes/Impacts/ Response						
Socioeconomic	17	13	11	6	16	0
Ecological	6	0	3	0	7	0
Legal action taken	4	5	0	1	7	0
Regulations						
Strong	2	2	1	2	3	3
Lacking	4	6	5	3	7	2
Media Influences						
Documentary	0	0	4	0	1	0
Advertising	0	1	0	1	1	0
Media Attention	0	0	0	0	1	0
Industry						
Positive	0	1	1	0	0	0
Negative	4	3	1	0	2	0
Decision-Making						
State	1	3	1	6	4	2
Local government holds no power	1	4	1	1	4	0
Public heard	0	2	1	0	0	0
Public not heard	1	1	1	0	2	0
Corruption	2	0	0	0	1	0
Description						
Fracking many years	--	4	2	2	4	4
Regulated many years	--	1	0	1	3	1
HVHF new tech	--	2	1	0	2	2
Future of County						
Stay same	--	1	0	0	0	0
Grow/Begin	--	0	0	0	0	0
Not grow/Begin	--	1	0	0	0	0
Depends gas price	--	2	1	0	0	0

Note: No data where indicated when lack of specific discussion of the case study counties.

National News Articles

This section provides a summary of the eight national news articles analyzed. Four of the eight articles cited the following four socioeconomic benefits and one ecological benefit: jobs (cited by two); increased economic revenue, large reserves, cleaner burning fuel than coal, and revenue to private landowners and the state (each cited by one). Four of the eight articles cited the following three socioeconomic risks and six ecological risks: water contamination (cited by three); the potential for surface spills/underground leaks and migration of gas and/or chemicals, disposal of wastewater, property values, and human health (cited by two); air pollution, noise pollution/light pollution/flares, water withdrawals, and ecological health (cited by one). For example, a Yale University study discovered that 18% of people living more than two kilometers from a HVHF well reported respiratory symptoms and 3% reported skin irritation. In comparison, 39% of people living less than one kilometer from a HVHF well reported respiratory symptoms and 13% reported skin irritation (as cited in Koch, 2014).

Seven of the eight national articles identified seven socioeconomic and three ecological impacts to the community, organizations, businesses, and public officials from HVHF operations. The following were cited by two articles: water contamination, wastewater disposal, companies not following through with their contracts with private landowners, and Chesapeake Energy Corporation's and Encana Oil and Gas USA's anti-trust violation in Michigan. The following were cited by one article: difficulties for property and homeowners to acquire mortgages/finance or refinance their property/attaining or renewing homeowners insurance, the formation of organizations and initiatives, legal actions taken to restrict or prevent HVHF in certain areas, noise

pollution/light pollution/flares, landscape changes, a changed community/culture, and potential for social and environmental justice issues.

Three of the eight articles discussed two topics in regards to the type of land where HVHF operations occur. Two articles discussed infringement of property rights and one article discussed split estate issues. One couple went through several unfortunate issues with their split estate situation. The couple wanted the state to perform free water test of their well after they believed it had been contaminated from a nearby HVHF well, but the state never did. Later, this same couple unsuccessfully tried to prevent a waste disposal pit from being put under their land and then unsuccessfully tried to prevent a company from laying down a gas pipeline on their property (Sontag, 2014).

Regulations were mentioned in four of the eight articles. One article identified the DEQ as the state department in charge of regulating HVHF activities. The following were each cited by two articles: the DEQ already has strong regulations over the industry and the DEQ does not oversee or regulate the industry well enough. Descriptions of the oil and gas industry were discussed in five of the eight articles. There were four main themes: 1) companies not holding their deals with private landowner, 2) the anti-trust violation of Chesapeake Energy Corporation and Encana Oil and Gas USA, 3) lobbying tactics and financial contributions, and 4) the strong persistence and tactics of oil and gas companies' landmen. Landmen are employees of oil and gas companies whose role is to negotiate with surface and mineral owners and acquire the lease and mineral rights necessary for companies to obtain a permit to develop those resources.

Two articles mentioned an issue that has occurred on several occasions with companies not holding up deals they previously made with private landowners. For

example, one family in North Dakota reported a 95% decrease in their royalty payments (Sontag, 2014). Nearly every company reviewed by the National Association of Royalty Owners in their 2007 report had "used affiliates and subsidiaries to reduce income to royalty owners and taxing authorities" (Lustgarten, 2014, p.8).

Two articles discussed the anti-trust violation of Chesapeake Energy Corporation and Encana Oil and Gas USA in Michigan. The companies were accused of collaborating in order to keep public and private lease prices low in Michigan (Lustgarten, 2014; Schneyer, Grow & Driver, 2014). Lower lease prices yield less total revenue received by the state and private landowners. Two articles described the industry's lobbying tactics and their financial contributions given to politicians (Sontag, 2014; SourceWatch, 2013). One article presented a report that found the industry spent $2.8 million lobbying in the State of Michigan alone (SourceWatch, 2013).

Two articles described the strong persistence of company landmen in obtaining leases from private owners. One article reported the story of a landowner who denied a lease offer by a landman. This landowner said the landman continued to call her and write her letters claiming that all of her neighbors had signed leases so she should too otherwise they would come and drill for the gas anyways (Berman, 2014). Another landowner in the same town described that the residents had a general perception that they were powerless in making any decisions about HVHF in their community, sharing that "industry kept telling us we have the power, you have none, we are coming, get out of the way or leave" (Berman, 2014). The underlying theme is that individuals and local communities feel powerless in regards to HVHF decisions.

The decision-making process regarding HVHF was discussed in four of the eight articles. Two articles presented citizen complaints of corrupt elected officials, one article criticized the HVHF decision making process for the lack inclusion of the general public, one article criticized the process for the lack of power held by the public and local governments, and one article mentioned that the industry's strong lobbying influences decisions. The Governor of North Dakota believes that the fear people have of HVHF stems from their lack of understanding of it. He said: There is a way to explain it that really relaxes people, that makes them understand this is not a dangerous thing that we're doing out here, that it's really very well managed and very safe and really the key to the future of not only North Dakota but really our entire nation" (Sontag, 2014, p.3). This identifies a need for improved communication and education regarding HVHF to the public. It is necessary for fair and honest information be presented so citizens can make unbiased decisions and improve their trust in regulatory agencies and the industry.

State News Articles

This section provides a summary of the sixteen state news articles reporting on HVHF. Six of the sixteen articles identified six socioeconomic benefits and two ecological benefits of HVHF, including: revenue to the state and private landowners (cited by five); large reserves/availability, increased economic revenue, and jobs (each cited by two); increased production, lower energy prices, cleaner burning fuel than coal, decreases the number of wells that need to be drilled/less surface development (each cited by one). The last benefit listed (decreases the number of wells that need to be drilled/less surface development) was further described, explaining two things: (1) HVHF reduces

the number of wells that need to be drilled, reducing surface development and fragmentation and (2) the revenue private landowners and the state receive from oil and gas leases have allowed for open spaces to remain that may not have otherwise due to the cost associated with owning land (Bauss, 2013). A University of Michigan poll of local government leaders found that 43% of the respondents stated income for private landowners as the primary reason for encouraging HVHF developments (Ivacko & Horner, 2014).

Eleven of the sixteen articles identified six socioeconomic risks and eight risks of HVHF, including: large use of freshwater/large water withdrawals (cited by eight); risks of surface, ground, or drinking water contamination (cited by seven); use of chemicals and additives in HVHF fluid (cited by four); air pollution/contribution to climate change, property values/property rights, non-disclosure of chemicals used, potential for surface spills/underground leaks and migrations of gas and/or chemicals, and human health (cited by two); changed community/culture, potential to reduce economic viability/impact local tourism and recreation, road damage, earthquakes, changed landscape, and environmental concerns (each cited one time). Tom Baird, first vice president of the Anglers of the Au Sable, stated: "the big issue is water use. They're pulling fresh water from nearby aquifers to the surface. That causes a drawdown of the aquifer, and can have an adverse effect on streams and rivers and their flow" (Wheeler, 2014). In addition, the University of Michigan's poll of local government leaders revealed that the risks HVHF poses to water resources was a concern shared by 57% of respondents (Ivacko & Horner, 2014).

Community or business impacts from current HVHF operations or the potential for HVHF were cited by twelve of the sixteen articles. These include: notifications of

public meetings and presentations being held to help answer questions and share information with local governments and the public (cited by four); prompted the MDEQ to propose new regulations (cited by three); personal/emotional impacts, created tension between the business community and the state's tourism industry, prompted the EPA to do a new study of HVHF, spurred the formation of various citizen groups, caused different organizations to work together, and motivated the WMEAC to rent billboards and display HVHF facts (each cited by one).

The type of land where HVHF operations occur or might occur, public trust discussions, and property rights issues were cited in nine of the sixteen articles. Four articles discussed the strong public opposition to the location of state lease auctions of public land areas where the MDNR had or was planning to lease mineral rights, including an area along the Au Sable Rivers "holy waters" and under an area of Hartwick Pines State Park near Crawford County and under the Barry State Game Area and Yankee Springs Recreation Area in Barry County. (French, 2014; Wheeler). Three articles argued the MDNR had violated the public trust by leasing public lands without public consent or without doing a prior environmental assessment. Protesters at one of the MDNR's public lease auctions also mentioned that only the auctioneer and registered bidders are allowed to speak, excluding the opportunity for public comment. One of the protesters exclaimed: "why are we selling the right for them to poison us for pennies?...At $10 per acre, we're subsidizing the industry. Billions in gas profits. Pennies for Michigan. Drink benzene!" (Lesert, 2012). Some individuals believe that the price the State sells leases for is way too low. This particular individual implied that the low lease prices allow for large profits to companies, but very little financial benefit to the State. In addition, the industry's

activities may result in contamination that can lead to harmful human health effects to Michigan citizens.

The issue of property rights was discussed in one of the articles, which reported that a HVHF well was permitted on public land, but sited very close to a residential neighborhood and nature preserve. Split estate issues were discussed in two of the articles. The MDEQ can approve a company's drilling permit even if the drilling unit is not completely leased, pooled, or communitized (e.g. the company does not own all of the mineral leases to the reserve). This strips away the choice for private landowners to decide whether or not they want to be a part of the drilling unit (Occhipinti, 2014).

With regard to regulations, ten of the sixteen articles cited a total of five topics. Two articles supported the MDEQ's regulations, with reporting they have strong regulations over the industry and another reporting of the new regulations implemented in 2011 and the MDEQ's 2014 proposed updated rules. Four articles critiqued the MDEQ for not providing adequate oversight and protection to the state's resources, public, and wildlife health. Two of these four articles suggested the following improvements: 1) improve the assessment of potential impacts, including cumulative impacts, that may ensue from the requested water withdrawals when permitting new wells, 2) disclose of the chemicals used in the fracturing fluid prior to drilling, 3) require water quantity tests before, during, and after operations, 4) require water quality tests before, during, and after operations, and also increasing the number of chemicals tested for (Alliance for the Great Lakes et al., 2014; Occhipinti, 2014). Two articles reported comments by groups or citizens implying the law favors industry over local communities. Three articles critiqued

the 2006 Michigan Zoning and Enabling Act, which denies local governments power, giving all the regulatory power to the state (Wozniak, 2014).

Decision-making was discussed in seven of the sixteen articles. Three articles mentioned the inability for townships and counties to regulate HVHF, proposing local governments should have more decision-making and regulatory power. Most townships and counties desire at least some authority to regulate HVHF in their area. The University of Michigan's poll found that 63% of respondents said local government officials should have "a great deal" of power to regulate HVHF (Ivacko & Horner, 2014). One article highlighted a few local governments that have found ways to pass ordinances, zoning rules, and implement temporary moratoriums, but they will most likely face legal challenges in the future (Payette, 2014). One article applauded the MDNR for listening to the concerns of citizens and organization when they changed the lease type to "non-development" leases along the Au Sable River's "holy waters."

Public opinions of HVHF were discussed in five of the sixteen articles. Two articles implied that there are very mixed feelings about HVHF, two articles implied that residents are concerned or against HVHF, one article implied support for HVHF, and one article mentioned how it is a very controversial topic. Two articles mentioned the lawsuit filed by the MLAWD, which argued the MDNR should have done an assessment of the potential risks of drilling prior to leasing the state lands in Barry County (Zipp, 2013). The following were each discussed in one article: a protest held in 2012 against the MDNR's auction of public land leases and a grassroots effort to try and pass a moratorium on HVHF in the state's 2014 ballot. One reporter communicated her personal opinion of Michigan resident's perceptions of HVHF, saying that not all residents are

opposed to having any HVHF operations in the state, but they are more opposed to having it on or near residential or fragile areas. The reporter also wrote that Michigan residents "are also aghast at the reality that their collective voices do not matter" (Wozniak, 2014). One article reported the findings from the University of Michigan's poll, in which respondents estimated the perceptions of HVHF in their communities: 37% of respondents believed that more of their citizens oppose it, while 11% of respondents believed more of their citizens support it; 29% of local councils and local boards are opposed, 16% are supportive, and 28% are neutral to having HVHF in their communities (Ivacko & Horner, 2014).

The oil and gas industry was discussed in six of the ten articles. Three articles described companies in a negative manner, including: one reported on Encana Oil and GAs's HVHF operation in Kalkaska that required over 21 million gallons of water to complete, one accused Encana Oil and Gas USA of causing the North Branch of the Manistee River to nearly dry up from their nearby HVHF operation, and the anti-trust scandal involving Encana Oil and Gas USA and Chesapeake Energy. Two articles were neutral in their descriptions of the companies present in the county, sharing their names and recent operations. One article positively described the industry, sharing the perception of an individual who trusts that the oil and gas companies in their communities care about the areas water as much as the residents do.

Five of the sixteen articles included a brief description of Michigan's past history with the industry. One article included the statement by the MDEQ reminding the public the agency has been regulating the industry safely for a very long time (Kloosterman, 2013). Four articles mentioned "fracking" has been done in Michigan for several decades

(Acosta, 2014; Bauss, 2013; Kloosterman, 2013; Williams, 2014). Only one of these five articles described the difference between vertical and horizontal drilling (Harger, 2013; Williams, 2014).

The future of HVHF in the State, Crawford, and Barry were discussed in three of the sixteen articles. One of the articles said the production in the Crawford County area has slowed due to the low gas prices, but once gas prices increase, the area will see an increase in gas developments. One of the articles discussing Barry County, highlighted the fact that even though many leases have been signed with oil and gas companies throughout the county, the MDEQ has not receive any permit applications to drill in the county or anywhere in West Michigan. According to the Michigan Oil and Gas Association, drilling in Michigan is down 8% right now (Harger, 2014). Another article reported the University of Michigan poll, which asked local government officials about their support or opposition to other energy options that can be developed in Michigan. Strongest support was for renewable energy power with support for HVHF coming in second to last, only ahead of offshore drilling (Ivacko & Horner, 2014).

Local and Regional News Articles Reporting on Crawford County

This section includes a summary of eight local and regional news articles reporting specifically on Crawford County. Three of the eight articles identified five socioeconomic benefits, which are as follows: The following were each cited in two articles: energy independence, jobs, and increased production/ability to produce from formations previously unattainable (cited by two); reduced energy costs, ability to produce from formations previously inaccessible, and increased production (cited by

one). One of the articles that cited jobs noted that none of the workers who installed a pipeline for a new HVHF well in Crawford County were from Michigan. An article presented a statement by Congressman Fred Upton's in which he praised HVHF for allowing the U.S to become the world's largest producer of natural gas (Alexander, 2013).

Six of the eight articles identified five socioeconomic risks and eight ecological risks, including: Large water withdrawals (cited by five); risk of surface, ground, or drinking water contamination, use of chemicals, and wastewater disposal (each cited by three); air pollution, changed landscape/new construction and development, and ecological health/environmental harm (each cited by two); human health, surface spills/potential for underground leaks and the migration of gas and/or chemicals, decreases property values, noise pollution, truck traffic, changed community/culture, and potential to reduce the economic viability/local businesses, tourism, and recreation (each cited by one).

One of the articles wrote about the well in Kalkaska County, Michigan that required 21 million gallons of water to complete and also mentioned the MDEQ has received permit applications requesting permission to use up to 35 million gallons of water per well. Bill Duley, a MDEQ geologist, explained that the MDEQ does not approve a permit if the proposed water withdrawals will harm the aquifer or nearby waters. He further explained: "when you burn natural gas (methane), you create carbon dioxide and water, which, will eventually return to the water cycle as rain" (Rankin, 2013). Bill Duley's explanation did not ease Rita Chapman's concerns, the Beyond Natural Gas Program Coordinator for Michigan, who responded: "the problem is that

water does not go back into the aquifer it came from, as rain, it ends up somewhere else" (Rankin, 2013).

Three of the articles mentioned the location of the HVHF well in Crawford County, which is on public land. One of the articles described the MDNR's delisting of mineral leases in an area under Hartwick Pines State Park after receiving a letter from the grandchildren of the woman who donated the land to the state many years ago. One article claimed the MDEQ violated public trust when they leased an area along the Au Sable Rivers "Holy Waters."

Community or business impacts from the presence of the HVHF well in Crawford County and the potential for new wells were identified in five of the eight articles. Two articles highlighted how HVHF in Michigan has spurred two university studies, one by Michigan State University and one the University of Michigan. Two articles discussed personal impacts to community members. One article reported an upcoming community meeting to answer questions and share information on HVHF and another article discussed resident's efforts to take time an educate themselves on HVHF. One of these articles reported that the HVHF well in Crawford County is on public land, but located extremely close to private property, which has caused disturbances to the residents. Some of the other impacts cited include: truck traffic/road damage, changed landscape/new construction and development, noise pollution/flares, changed community/culture/potential for social or environmental justice issues, decrease in property values, wastewater and brine found to be spread on roads for dust control, and possible groundwater contamination. The homeowners living near the HVHF experienced many disturbances. On several occasions they reported having their

driveway blocked during the construction of the new pipeline. The homeowners said the workers grudgingly moved for them, but on at least one occasion the workers were unwilling to move for the homeowners, so the sheriff was called (Minolli, 2014).

Regulatory exemptions were identified in two of the eight articles. One article cited exemptions from the SDWA and the CWA. The other article noted the 'Halliburton Loophole' and described the proposed Senate Bill 552, which would give companies' property tax exemptions, if passed. Current HVHF regulations were mentioned in four of the eight articles. The MDEQ was cited three times as the agency in charge of regulating the industry and the MDNR was cited two times as the agency in charge of leasing state owned mineral rights. One article reported that the MDEQ has strong regulations over the industry. Four articles reported that the MDEQ's regulations are not strong enough and need to be improved. The Michigan Water Withdrawal Assessment Tool is used by the DEQ to determine if proposed withdrawals would cause an adverse impact on nearby waters, but was criticized because only 2% of all rivers and streams in Michigan contain gauges that measure stream flows. The article believes the tool largely overestimates stream flow. Another criticism involves permit approvals, which can remain confidential up to 90 days after the company has reached the depth of the well.

The influences of documentaries were cited in two of the eight articles. Two articles reported that public awareness and public concerns of HVHF increased after the release of the documentary 'Gasland.' One letter to the editor included the resident's suggestion for readers to watch the following movies: 'Gasland' 1, 'Gasland' 2, and Promise Land. Discussion of Encana Oil and Gas USA (owner of the active HVHF well at time the article was written) took place in two of the eight articles. One article

presented a negative perspective on the company and the other article presented a positive perspective on the company. Decision-making was discussed in three of the eight articles. One article shared that the state holds all the power to regulate the industry. Two articles critiqued this fact; with one sharing that local governments should hold some power to make decisions and the other article sharing that individual resident's are not heard. Another article implied that the concerns of citizens are heard because the MDEQ responded and changed leases along the Au Sable River to "non-development" leases.

Two of the eight articles discussed the fact that "fracking" has been done in Michigan for many years. One of these two articles quoted a MDEQ representative making this statement. The other article shared this fact and also included an explanation of the difference between the two types of natural gas extraction techniques. The future of Crawford County was briefly discussed in one of the eight articles, which mentioned how the low gas prices have currently slowed activity in the area, but predicted that it will probably increase again when gas prices rise.

Local and Regional News Articles Reporting on Barry County

This section provides a summary of four local and regional news articles reporting on Barry County. One of the four articles identified the following three socioeconomic benefits of HVHF: increases economic revenue, energy independence, and jobs. According to the Natural Gas Subcommittee report, "increasing Michigan's extraction, production, & transportation of natural gas will create 'thousands of energy jobs throughout our state' which would 'generate $2 billion in economic activity, making Michigan a key producer'" (Lesert, 2013).

Three of the four articles identified the following three socioeconomic and six ecological risks: The following were cited three times: ecological health/environmental harm (cited by three); large water withdrawals, use of chemicals and additives in HVHF fluid, surface spills/potential for gas and/or chemical migration, and changed community/culture/potential for social and environmental justice issues (each cited by two); human health, water contamination, wastewater disposal, truck traffic, and changed landscape (each cited by one). One article reported the findings from two HVHF studies. The first was Duke University's study that found water wells near HVHF sites can have methane concentrations up to 17 times higher than water wells far from HVHF sites. The second was the study done by Dr. Anthony Ingraffea, which revealed that of the wells studied, 6% -12% of the cement and steel casings leaked (as cited in Lesert, 2014).

Land type was discussed in one of the four articles, which identified a public trust concern. This article discussed the MLAWD's claim that the MDNR had violated public trust by auctioning the public land leases in Barry County without doing an environmental assessment first. All four of the four articles reported impacts to the community and business in Barry County from the numerous numbers of minerals leased by oil and gas companies and the potential for HVHF. These include: reports of two different meetings being held to discuss HVHF and educate the public and identification of two ongoing academic studies of HVHF (each cited by two); the legal action taken by the MLAWD and the WMEAC's "fracts" billboards aimed to educate the public about HVHF (each cited by one).

The current HVHF regulations were discussed in three of the four articles. Two articles presented both positives and negatives of the regulations.[7] One of the articles reported opinions that the MDEQ's regulations are lacking, with one that criticized the lack of a chemical disclosure requirement. One article highlighted the following advice of an environmental lawyer for local governments trying to protect their communities from HVHF: 1) use zoning powers, 2) sue under the Michigan Environmental Protection Act or sue under the Clean Water Act, and 3) request documents through the Freedom of Information Act (Faverman, 2015).

Decision-making was cited in all four of the articles. Three articles discussed the MDNR's role, three articles discussed the MDEQ's role, and 1 article discussed the company's involvement. One of these articles presented some organizations, public officials, and citizens' disagreements with the fact that the states hold all the power to make decisions and regulate HVHF, leaving local governments with no voice in making decisions in their own communities.

Two of the four articles reminded readers that "fracking" is not new to Michigan and has been regulated by the state for a long time. An MDEQ employee's statement that there have been no reports of contamination in Michigan was cited in one of the articles. Neither of the articles described the difference between the vertical and horizontal drilling and fracturing techniques.

[7] One shared statements by MDEQ representatives saying that they have very strong regulations and described it as a "cradle to grave" regulatory process. The MDEQ was later criticized for having 25 employees in charge of inspecting the thousands of active wells around the state (Faverman, 2015).

Publications by Environmental and Oil and Gas Organizations and a Company

This section provides a summary of the findings from the nineteen publications by a company, organizations, industry groups, and blogs. Nine of the nineteen articles identified eight socioeconomic benefits and two ecological benefits of HVHF, including: job creation (cited in six publications); revenue to the state and private landowners (cited in six publications); Lower energy prices/affordable, energy security/energy independence, and economic revenue/growth/reviving industry (each in four of the publications); reduced CO_2 emissions/clean fuel (each cited in three publications); abundant supply/reliable (cited in two publications); ability to produce from formations previously unattainable, step towards an increased use of clean energy, and decreases the total number of wells drilled/reduces surface development (cited in one publication). The Headwaters Institute's study of oil and gas developments reported strong initial community benefits accompanying new developments, such as increased employment and income. However long-term community impacts, such as reduced income, increased crime rates, and a decline in education rates, were found to greatly outweigh the initial benefits (as cited in Fracklist, 2014).

Thirteen of the nineteen publications identified six socioeconomic risks and nine ecological risks, including: large use of freshwater/large water withdrawals (cited nine); use of chemicals/disposal of chemicals, drill cuttings, and drilling muds and human health/reduced quality of life (each cited in six); noise pollution/light pollution and surface water/groundwater/drinking water contamination (each cited in five); decreases property values, ecological health/environmental impacts, air pollution/contribution to climate change, and the flowback/wastewater (each identified in four); truck traffic/road

damage, surface spills/potential for underground leaks and for gas and/or chemical migration, potential to reduce economic viability/local business, tourism, and recreation, changed landscape/new construction and development, and potential for changed community/culture/social and environmental justice issues (each mentioned in three); potential for earthquakes (each cited in two).

The large water withdrawals required for HVHF was a main concern in these publications. One post reported the five permitted wells in Michigan are estimated to use a combined total of approximately 132 million gallons of freshwater (Kozma, 2014). Another major concern is with the additives, which can include sands, chemicals, biocides, acids, and lubricants. Some of the chemicals are carcinogenic, hormone disruptors, and harm reproductive health. Furthermore, the water can return with additional components like mercury, arsenic, or radioactivity (American Rivers, 2011; FARwatershed, n.d.;Kozma, 2014).

The benefits and risks associated with HVHF and different land types were discussed in five of the nineteen publications. Three articles described public trust issues and one article described the issue of split estate. Private landowners have very little say, with three common examples of this: (1) The DEQ may permit a new HVHF well on public land, it might be close to private property. (2) If a private landowner does not own the mineral rights under their land and a company leases these mineral rights from the state, the company holds the right to drill for the resources whether or not the private landowner has signed a lease or wants any development on or under their property. (3) Private landowners can be "forced pooled," meaning they can be included in a large drilling unit whether or not they sign a lease if the company owns a large enough percent

of the drilling unit. This means the company can drill under a private landowner's land without permission from all private landowners. One article discussing Barry County explained that most of the state mineral leases purchased by companies were "non-development" leases. This spurred a large rush to try and get private landowners near the public lands to sign leases so they can develop on the surface of private land and then horizontally fracture to reach the minerals under the state land. The following were each noted in four articles: the DNR needs to take the public interest into consideration, needs to identify sensitive, unique, and special areas before putting lands up for auction, and needs to provide stronger protection from fragmentation in conservation areas.

Ten of the nineteen publications reported impacts to communities and businesses from HVHF operations of the potential for HVHF operations. These include: HVHF was the reason for the formation of three new organizations, three different meetings being held in the state, one with a presentation to local governments by the For Love of Water organization (FLOW), and the other two were public educational meetings, actions taken by a few local governments to try and pass ordinances, moratoriums, or bans (cited in three); how close HVHF wells can sited to homes (cited in two). One publication reported that HVHF wells have been sited as close as 450 feet away from homes in Scio and Shelby townships in Michigan (MLAWD, 2014). A few landowners and the MLAWD organization have taken legal action in response to HVHF impacts or potential impacts by filing lawsuits (cited in two articles). The increase in HVHF activity in Michigan have spurred on two university studies; a HVHF operation in Kalkaska may have caused the North Branch of the Manistee River to nearly dry up; a HVHF operation in Northern Michigan was likely the cause of a nearby private water well to go dry;

involvement from the Anglers of the Au Sable to protect the Au Sable River from development; sparked the desire of organizations and citizens for a federal database that would report the locations, water use, and chemical use of HVHF sites; air pollution, noise pollution, and land contamination for residents living near HVHF wells in Michigan; the support of HVHF for increasing revenue flow into rural communities (each cited in one).

The following five examples were reported in one article: (1) the flowback water and brines from various HVHF wells were spread on several Northern Michigan roads for dust control in 2012 and 2013. Tests in the area detected the chemical AI-2 at one location and a radioactive substance at a different location. (2) Team Services LLC. spilled the contaminated brines carried by three tanker trucks on public roads in Benzie County, Michigan. The BTEXs concentrations from this area were 2,000 times the MDEQ limits. (3) Drill cuttings and drilling muds were sent to a solid waste landfill in Gladwin, Michigan without being tested for radioactivity. (4) The HVHF fluids at a well in Benzie County, Michigan came up from the well and spilled out, causing soil contamination and possibly groundwater pollution as well. (5) In July 2013, the improper closure of a storage tank valve caused 300-400 gallons of flowback water and brine to spill out at the site in Kalkaska County, MI (Kozma, 2014).

HVHF regulations were discussed in eleven of the nineteen publications. The following exemptions were cited: Ten regulatory exemptions were cited in three of the publications.[8] The publications discussed the following about HVHF regulation: seven

[8] The 'Halliburton Loophole' (by one article); the SDWA and the lack of a chemical disclosure requirement (each cited in two articles); the CAA, CWA, RCRA, CERCLA,

articles identified the MDEQ as the agency with the duty to permit and regulate HVHF activities; three articles stated that the MDEQ has very strong and adequate regulations over the industry; six articles mentioned the regulations and oversight of HVHF activities are inadequate. Three of these eleven articles commended the State of Michigan for having strong regulations over the "fracking" for many years, no reported cases of drinking water contamination. One of the eleven publications included a previous MDEQ employee's statement that the department stopped publically sharing contamination incidents in 1995, making it difficult to know if their claims that no contamination has occurred are true. Two of the eleven articles included suggestions for improvement. A suggestion presented in one publication is to pass the Fracturing Responsibility and Awareness Act (FRAC ACT), which would require compliance with the SDWA and chemical disclosure to the state and public (American Rivers et al, 2011). The other publication called for an upgrade to Michigan's Water Withdrawal Assessment tool, suggested baseline studies on water quality and water quantity, and urged the DEQ to require companies to share full chemical composition, the water quantity required, and treatment of the wastewater as a hazardous waste prior to approving permit applications (Anglers of the Au Sable, 2014).

Eleven of the nineteen articles presented insights on public opinions of HVHF. One article highlighted a 2014 public opinion study on HVHF reported the following opinions in Michigan: (1) 54% supported and 35% opposed HVHF, (2) 45% of respondents reported the word fracking had a negative connotation and 31% reported a

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NEPA, EPCRA, and the Michigan Water Withdrawal Statute (all identified in one article).

positive connotation (Anglers of the Au Sable, 2014). Three publications reported supportive opinions; two publications reported a sense of mixed feelings; five publications reported the public had many concerns and were in opposition; one publication reported of a petition to ban fracking in Michigan; and one article reported a protest that took place at one of the MDNR's lease auctions. One of these articles reported that there seems to be a strong sense of NIMBYism (not in my backyard) associated with HVHF.

Two articles discussed influences from the media. One article reported that documentaries and the increased media attention given to HVHF has increase public awareness and concerns. The other article mentioned the numerous number of billboards the industry has around the state to advertise and increase public support for natural gas.

Decision-making regarding HVHF was discussed in six of the nineteen publications, consistently expressing that the state makes the decisions, giving local governments no say in the process. One article remarked that part of the MDEQ's role is to foster the development of oil and gas and highlighted the MDEQ's close business relationship with the industry. Two articles urged for citizens and organizations to educate our legislatures, contact them, and hold them accountable.

Michigan's past history with the oil and gas industry was discussed in five of the nineteen publications. Four publications noted that "fracking" has been done for many years in Michigan and three publications noted that "fracking" has been regulated in Michigan for many years. One blog post referred to the MDEQ's commonly made statement that "fracking" has been done for many years and has had 12,000 wells already drilled in Michigan as a 'bogus statement.' The blog criticized this statement for implying

that there have been no new changes in fracturing techniques. Only two of these five articles explained the difference between vertical and horizontal wells. Two articles explained that the first HVHF well in Michigan was drilled in Kalkaska County in 2010. Two of the nineteen articles expressed the desire for an increase in the development of renewable energy sources going into the future.

Government Publications

This section includes a summary of the five government sources reviewed. The following three socioeconomic and one ecological benefits of HVHF identified include: the United State's abundant supply of natural gas (cited by two); increased production/ability to produce from formations previously unattainable (cited by two); an important step towards increasing the United State's development of clean energy (cited by two); and revenue to the state (cited by one). The state receives income from the following: the bonus payment paid by the lessee to purchase a lease, the rent fees the lessee pays for the number of acres leased, and from royalty payments for wells that produce. The revenue the state gains from these payments must be put into the Michigan State Parks Endowment Fund and the Game and Fish Protection Trust Fund. By leasing state-owned oil and gas rights, the State of Michigan has grossed a combined total over $750 million dollars over the last 10 fiscal years (MDNR, n.d.). One of the articles cited the Energy Information Administration's forecast, which estimates the United States natural gas reserves will last us 110 years (as cited in U.S. House, 2011).

Two socioeconomic risks and six ecological risks of HVHF were identified in two of the five articles, including: human health, use of chemicals and additives in HVHF

fluids/disposal of chemicals, and wastewater storage and disposal (each cited in two); water withdrawals, chemical non-disclosure, the potential for surface spills/underground leaks and migration of gas and/or chemicals, risks to surface water, groundwater, and drinking water contamination, and ecological health (each cited in one).

Split estate was discussed in one of the five articles, which explained that the split estate situation might occur because the mineral estate is deemed the dominant estate. Decision-making and regulations were discussed in three of the articles. The MDNR makes the final approval of state-owned leases auctioned, but they do accept public comment. The MDEQ Office of Oil, Gas, and Minerals was identified in two articles as the department in charge of permitting and regulating oil and gas development.

HVHF regulations were mentioned in all five articles. The MDNR's authority to lease state-owned mineral rights and the MDEQ's authority to regulate oil and gas development is stated in the Natural Resources and Environmental Protection Act. Three publications explained a few of the regulations. Two publications mentioned that the MDEQ has very stringent regulations and oversight of the industry, with the goal to protect public health and safety. Even though requirements and regulations exist, two of the five publications presented concerns with the current regulations. The following were each cited in one publication: the SDWA exemption, exemption from Michigan's Water Withdrawal Statute, lack of a public disclosure law at the federal level, lack of requirement for baseline water testing, and the OSHA rule that does not require companies to share products they consider "trade secrets." Furthermore, some of the products companies purchase "off the shelf" from chemical suppliers are considered proprietary information. This means some companies do not always know what

chemicals they are injecting underground and therefore cannot adequately distinguish potential risks to ensure safe operations (U.S. House, 2011).

Three articles discussed Michigan's past history with the oil and gas industry. One article reported that the MDNR has held lease auctions of state-owned mineral leases since 1929. Two articles noted that "fracking" has been done in Michigan for 60 years. One article reported that the technique has been used in Michigan since 1952, more than 12,000 wells have been drilled in the state with no reported cases of contamination, and stated there is no new "fracking"; it is the same from a regulatory standpoint. This article explained two differences: the process involves tapping into deeper resources and the fracturing work is much larger, but that means they are further below the water table and reduce surface disturbance because a fewer number of wells need to be drilled. One other article also briefly noted the difference between vertical and horizontal drilling and fracturing.

The five subjects discussed the most by the sources in each category include: benefits, risks, land type, regulations, and decision-making. More risks were identified in the reviewed content than benefits. The top three most commonly cited benefits of HVHF in the analyzed content are as follows: (1) jobs (cited thirteen times), (2) revenue to the state and private landowners (cited thirteen times), and (3) increases economic revenue/growth/reviving industry (cited eight times). The top three most commonly cited risks of HVHF in the analyzed content are as follows: (1) large use of freshwater/large water withdrawals (cited 26 times), (2) risk of surface water, groundwater, drinking water contamination (cited 20 times), and (3) the use of chemicals and additives in the HVHF fluid/disposal of chemicals, drill cuttings, and drilling muds (cited seventeen times).

Appendix D: List of Abbreviations

CAA: Clean Air Act

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act

CWA: Clean Water Act

EPCRA: Emergency Planning and Community Right to Know Act

EPA: Environmental Protection Agency

FLOW: For Love of Water (organization)

FRAC Act: Fracturing Responsibility and Awareness of Chemicals Act

HVHF: Refers to the horizontal drilling and high-volume hydraulic fracturing technique

MDEQ: Michigan Department of Environmental Quality

MDNR: Michigan Department of Natural Resources

MLAWD: Michigan Land Air Water Defense

MSU: Michigan State University

NEPA: National Environmental Policy Act

NIMBY: Not In My Backyard

RCRA: Resource Conservation and Recovery Act

SDWA: Safe Drinking Water Act

SWDA: Solid Waste Disposal Act

WMEAC: West Michigan Environmental Action Council