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The Social, Economic, and Environmental Impacts of Rapid Energy Development on Local Communities: A Review of the Literature and Press Reports

Prepared for the American Petroleum Institute

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EXECUTIVE SUMMARY

Over the past decade, rapid energy development has been occurring in many communities across America, including areas of the country where mining is a completely new industry. Though the exploration, drilling and production of oil and natural gas from shale formations has brought significant economic and fiscal benefits to these communities, the past year has witnessed a growing chorus of allegations claiming that drilling—and especially hydraulic fracturing—is doing serious harm to the environment. Concerns have also been raised about possible negative social, cultural and "quality-of-life" impacts attending rapid energy development, though many of these concerns are based on conjecture rather than fact.

We have reviewed more than 150 recent studies and news articles that focus on the demographic, economic, environmental, infrastructure, and social/cultural impacts from energy development. These studies and articles focus primarily on communities where shale gas and shale oil production have grown rapidly over the past decade. The findings of these reports can be summarized as follows:

- Overwhelmingly, the effects of shale gas development on regions and communities are positive and sustainable beyond a short term time frame;

- Investment in shale gas development leads demonstrably to significant and beneficial increases in local employment, business spending at the regional/community level, and increased tax receipts, also at the regional and community levels;

- Short term adverse impacts do occur – notably in terms of traffic, housing, and demands on certain local services – but with effective planning by local governments and conscientious collaboration by operating companies, these impacts are largely mitigable and can be addressed in a 3 to 5-year time frame;

- The cycle of investment and returns from existing tax regimes are sufficient to provide adequate public sector revenues to respond to development-driven impacts without the addition of direct taxes on shale gas production, such as severance taxes;

- Environmental impacts from shale gas development are modest, even when the perceived scale of the development is great. What's more, these impacts can be mitigated to acceptable levels through planning, compliance with regulations and permit requirements, and operator attention to issues of site and road footprints, water use, appropriate offset distances from residences or sensitive habitats, and overall environmental and operations integrity;

- As a general rule, economic and social impacts may be experienced more acutely by smaller communities and/or by regions with less history in energy development

activities. This reality should be acknowledged but can be addressed in effective ways through two-way communication and effective local outreach;

- Economic studies that predict substantial overall benefits to regions and communities from shale gas development are being validated by operating experience on a year-to-year basis.

Introduction

Mineral development has many economic, social, environmental and cultural impacts on the communities from which the resources are extracted. When this development occurs rapidly, as has been the recent case over the past decade with shale gas and shale oil, these impacts are often amplified.

In order to better understand both the benefits and costs of rapid energy development for local communities, the Maguire Energy Institute in the Cox School of Business at Southern Methodist University has conducted a review of the professional literature as well as recent press reports that discuss the economic and social impacts of this development. Our findings are summarized below. However, the reader should keep in mind that since the "shale gas/oil revolution" is a relatively new phenomenon, a good deal of the media coverage regarding the "negative effects" of shale play development is based on assertions and opinions and not necessarily facts that have been "proven up" through careful research and analysis.

Nonetheless, claims and opinions, even if incorrect, often serve to shape a community's perceptions of how energy development is affecting their local economy, environment and social fabric. Indeed perceptions may have a greater influence on public reaction and public policies than the actual facts.

We have organized our findings into four sections: (1) rapid energy development, population growth and resulting social, cultural, and quality-of-life impacts; (2) economic and fiscal benefits and costs from shale oil and shale gas plays across the U.S.; (3) environmental and health impacts; and (4) infrastructure burdens and pipeline issues associated with rapid shale gas and shale oil development. Each section is comprised of a digest of the research

findings or journalistic "reportage" dealing with that particular topic. References to the various studies and articles from which the digests are compiled can be found in an appendix to this report.

I. Rapid energy development, population growth, and resulting social, cultural and "quality-of-life" impacts

When a "new" industry comes to town, such as shale gas and shale oil drilling and extraction, community patterns of daily living and daily commerce are often disrupted. Though the economic and fiscal benefits are almost always substantial, rapid energy development may have some direct and indirect negative impacts as well. Mineral development and the influx of population associated with it in the United States are often shrugged off as a tale of the boom-bust economy. While that may be true in the micro sense, the macro view is a different story.

Would Denver, Seattle, and cities throughout Northern California be as robust today if it weren't for gold rushes of the past? How many resort towns that dot the American West would even exist if it weren't for speculators looking to mine for silver, copper, and other ores in towns like Park City, Utah, Leadville, Colorado and Bisbee, Arizona? And what about Texas? The continual cycle of people "Gone to Texas" for the exploration and drilling of oil and gas spans decades. In each of these cases, there is a maturation of an industry and resulting economic development that quickly – and over time – provided economic benefits for the cities in question. The boom in unconventional oil and gas drilling is in some ways similar, with economic benefits but some negative externalities.

The current boom in shale plays is encouraging critics of the unconventional oil and gas

drilling industry to cite the influx of population in these regions as one in a laundry list of negative impacts. What often stands as the baseline of these critiques are two scholarly papers that have been cited numerous times throughout the academic literature regarding rapid energy development. Kohrs (1974) details rapid energy growth in rural Wyoming and coined the widely-used term the "Gillette Syndrome" referring to any social disruption arising from an energy industry-driven population influx while Gilmore (1976) bases his assertions on the "facts" presented in the first.[1] [2] These two seminal papers claim that population increases are responsible for increases in a wide range of social maladies including suicide, high school dropout rates, spousal abuse, mental illness, alcoholism, and drug use.

What critics neglect to acknowledge is that a few years after these papers were published, Wilkinson et al. (1982) closely examined the data – or lack thereof – and found little or no documented evidence to support their widely cited claims. [3] The authors detail how additional papers include similar claims of increased rates of child abuse, crime rates, and divorce to the mix. Again, they find no credible evidence to support these claims.

In other cases, Wilkinson et al. (1982) detail how empirical evidence is often misinterpreted, leading to results that are misleading. They write, "Flaws in scholarship are apparent in this literature in citations of undocumented assertions as evidence, questionable interpretations of empirical data, overgeneralizations of conclusions, and absence of controls in measures of relationships." To help explain how such unreliable research is undertaken and ultimately published, Wilkinson et al. (1982) suggest that the theoretical framework employed by many scholars is flawed. The canonized constructs of sociology that favor rural communities (and pace of life) over urban ones create a bias leading to the conclusion that "Urbanization,

rapid change, and outside domination are asserted to be sources of social pathology in western energy development communities."[4]

Given the perspective of time, Jacquet (2009) revisits Kohrs' work acknowledging its shortcomings, but he offers that subsequent studies on the social and cultural impacts of rapid energy growth in the years after Kohrs' work find social maladies appearing "at disproportionate rates when compared to non-booming communities."[5] He tempers this statement, however, by adding that the reasons for these increases in social maladies "have not been concretely determined" and suggests that blame is attributed generically.[6] The author then cites papers by Lantz and Halpern (1982), Freudenburg (1982), Brown (1978), Lantz and McKeown (1979), Moen, et. al (1981), and Vlieger (1985) among others as key works for the post-Kohrs discourse concerning rapid energy development and subjects like alcohol abuse, mental health, social service demand, gender issues, and crime.[7] [8] [9] [10] [11] [12] Adding to this discourse are authors such as Freudenburg (1984) and Freudenburg and Jones (1991) who claim correlations between rapid energy development and a higher incidence of social pathologies such as suicide, school dropout rates, alcoholism, social alienation, criminal activities, low self-esteem and drug use in affected communities. [13] [14] Research from Penn State's College of Agricultural Sciences Agricultural Research and Cooperative Extension also suggests that the population influx from rapid energy development will "likely" result in increases in nonviolent crimes. The Extension adds that "social tension" or "animosity" may emerge between new and established residents as well as those who have benefitted from the development and others who may feel left out of the windfalls.[15]

Academic research on the social and cultural impacts of rapid energy growth associated with recent shale plays and population influx is as dichotomous as the historical discourse it uses as a base. The qualitative data used are often a mix of objective fact and subjective perception. Theodori (2009) illuminates the situation of "paradoxical perceptions" concerning unconventional drilling while observing a wide variety of perceived issues in two Barnett Shale counties. The author notes that the county with the more mature drilling industry is less likely to view certain perceived impacts as negative.[16] Wynveen (2011) also surveys residents in two Barnett Shale counties about the community impacts of energy and finds that in terms of social consequences, respondents perceived threats regarding health and safety, traffic accidents and fatalities, gas well explosions, aesthetic degradation and loss of community identify and character. Like Theodori's (2009) findings, the perceptions differed between counties. In this case, respondents in the county that had a more mature drilling industry perceived environmental and convenience issues to be more threatening than respondents in the county with less drilling. The author's findings were based on only 66 usable survey responses from a sample of 1,533. What made the 66 surveys usable was the fact that these respondents offered additional information in the form of comments which may point to issues of self-selection bias.[17]

Brasier et al. (2011) conducted key informant interviews in four case study locations in both the Pennsylvania and New York Marcellus Shale. The authors found respondents were mostly positive about the effects of drilling on the local economy, but concern was raised over competition for workers, inflation, and a lack of local fiscal impacts. Concerns were especially prevalent when analyzing social impacts and included fears of rising population densities and

crime rates, loss of rural lifestyle, and inequalities amongst the "haves" and the "have-nots" and those who leased early and those who held out for better offers. Like Theodori (2009) and Wynveen (2011), the authors find differences between respondents depending on maturation of the industry and geographic location. For example, informants in the case study locations with comparatively more drilling activity were more apt to discuss "future impacts related to economic benefits, population increases, and roads." In addition, "They were also concerned about potential changes to local quality of life and environmental quality."

A history of natural resource extraction is also influential on perception with areas having an experience of prior resource extraction activity registering fewer concerns and a greater understanding of the potential impacts. Differences in perceptions also exist between locations near urban areas and those in rural locations. Urban areas offer better existing infrastructure and can more easily absorb workers into the local economy while rural areas may suffer from a lack of existing social and physical infrastructure. Informants in all four case study areas, however, did point to the overall region's experience with coal extraction as a cautionary tale.[18] Again, the respondents' insights were based on a mix of perception and reality. An example of the dubious reliability of the qualitative data is offered when discussing population growth. The authors state that "Respondents in Lycoming and Washington Counties were concerned that the population growth might increase demands on law enforcement, social services, schools, and emergency management, but did not describe actually observing these changes." Fears of environmental degradation were also prevalent, but unsubstantiated.[19]

Outside of academic literature, there is no shortage of conjecture concerning recent shale plays and the population influx they've facilitated. A state senator in Pennsylvania

recently claimed that Marcellus communities in the state were witnessing a rapid increase in sexually transmitted diseases.[20] Though cases of gonorrhea were up 50 percent from the previous year and cases of chlamydia up 26 percent, there is no proof tying these statistics to an influx of shale workers. Rising truck traffic, vehicle accidents, and noise pursuant to shale gas and shale oil development are common complaints appearing in media reports.[21] [22] One story claims that excessive noise resulted in serious family illness.[23] Even in Dallas, Texas – which has yet to see any drilling — potential noise from rigs, trucks, compressors and other equipment is viewed as a major concern.[24]

Some media reports are more unbiased than others. For example, a story concerning the Marcellus Shale play in Pennsylvania and the "rough crew" it is attracting details the double- digit rise in crimes like DUIs in Pennsylvania as well as North Dakota and Wyoming. The article also interviews gas workers who point out that "many in the industry obey the law" and that trouble sometimes stems from not initially understanding cultural differences between states in terms of how authorities address after-work recreation activities. One interviewee, a drilling-equipment supervisor in his 30s, sees the problem not as one tied to the drilling industry but to "young people making a lot of money." The interviewee adds, "I'm not that much of a wild person."[25] Similar stories are found in community newspapers in the Bakken Shale play in North Dakota. For example, the local newspaper in the North Dakota town of Williston receives complaints about the temporary housing encampments constructed to house newly arrived workers. The areas are referred to as "ghettos" and the people who inhabit them are called "oil-field trash."[26] Despite this characterization, when a national reporter investigates the residents of a temporary housing residence, he finds a long trailer with multiple rooms each

with a flat screen TV and an atmosphere that workers claim is "largely peaceful." One worker comments that after working a physically demanding twelve hour shift all one can really manage is to eat, do laundry, and sleep.[27]

A common assertion leveled against the unconventional oil and gas drilling industry is that the workers are merely transient and will not remain as members of their host communities once the initial development process is over. In some cases that is a fair critique, but a broader understanding of the workforce required to develop and maintain a shale play is needed as well as a sense of growing trends. The workforce needed to develop and maintain a shale play is a cross-section of scientific specialists in the fields of engineering and geosciences, skilled and semi-skilled technicians, and general labor. In the initial, short term window of development, workers from outside of the community are often brought in due to their skills and knowledge not being matched by the workforce in the local community. Once the well is operating and in the "production" phase, it may remain that way for several decades necessitating a workforce trained in attending to its needs.[28]

Currently, drilling in the Marcellus Shale is largely relying on an "out-of-town" workforce; but substantial efforts are being made to quickly educate and train a local workforce. Additionally, once local workers are trained not only will they have job opportunities in the community but they'll also have the skills needed to join the larger, mobile workforce working shale gas plays nationally and internationally. Evidence is also emerging that over time many out-of-town employees decide to remain in their new communities, and companies sometimes establish regional offices in these new locations. Already in southwestern Pennsylvania "where shale gas development has been occurring since 2004," a "transition

towards local workers" is slowly taking place.[29]

Media reports concerning rapid energy development in North Dakota are largely favorable. North Dakota embraced the unconventional oil and gas drilling industry and is now the fourth-largest producer in the United States. The state is one of the few places in the country today where jobs are plentiful. North Dakota has the nation's lowest unemployment rate as well as the fastest rising per capita income level. From 2000 to 2010, the state's population increased 4.7% with Fargo's population now over 100,000 and the town of Williston boasting almost 15,000 residents – a 17.6% gain.[30] Along with Fargo and Williston, Bismarck is also a magnet for new residents who have made possible the city's 23% increase in high-paying energy jobs and 40% increase in professional jobs. Across the state, employment in the energy industry jumped from 5,000 in 2005 to 30,000 in 2011.[31]

However it is framed, a population influx that revolves around rapid energy development may contain elements that are positive to some and perceived as negative to others. What is important in this modern age of rapid energy development is the ability to quickly plan for growth in order to ensure the best possible scenario for all residents of a community. Williamsport (PA) City Councilman Jonathan Williamson understands this need for planning and achieving balance between old and new in terms of economic development by stating, "Let's do natural gas but make sure we don't ignore our existing industries and don't ignore the need for developing ones."[32] Jacquet (2009) raises the importance of planning when addressing rapid energy development and offers a body of literature that examines the planning challenges faced by municipalities in previous energy plays.[33] The author offers Markussen's (1978) typology of limitations affecting local governments in rapid energy

development and details the seven categories: [34]

> a) Jurisdictional unevenness: The energy development prompting population growth takes place in a political jurisdiction different from the one which bears the cost. In such instances the community bearing the brunt of the growth cannot control the development and may not receive mitigation funds because the development is elsewhere; b) New Comers vs. Old Timers: Rapid growth frequently requires major new infrastructure expenditures to accommodate new residents and older residents may oppose subsidizing such expenditures under uniform taxation arrangements. New residents may have substantially different expectations and preferences for levels of public service than older residents; c) Insufficient control of land use: decisions about disposition of land as in federal coal or offshore leasing prevents the local government from using zoning or siting arrangements to ease adjustment; d) Severity of growth: Sheer numbers of people entering to work, despite adequate housing, may be unassimilatable without significant declines in quality of public services and community life; e) Volatile production patterns: The boom-bust cycle associated with energy development presents the local government with an uneven future path of public service demand; f) Monopoly of information: the industry or regulatory agency exercises tremendous power over the pace of development and the amount of information that is available to planners; sometimes, an incentive to misinform exists; g) Risk: The uncertainty surrounding the future of many energy activities raises the risk premium, often so high that the financial sector is unwilling to lend funds to or buy bonds of local governments.[35]

Jacquet (2009) also offers the work of Cummings and Mehr (1977) who discuss the contentious nature of growth projections associated with rapid energy development; Ervin (1978) who notes a disconnect between the immediate need for expanded services due to a population influx while revenue lags behind; Susskind and O'Hare (1977) and Ervin (1978) who detail the problems local municipalities may face even with adequate funding such as restrictive laws, staff shortages or inexperience, long lead times for projects, or a public unwilling to reach a consensus in policy matters; and Gilmore (1976) and Richards (1976) who reason that growth rates of 5-6% annually in rural areas are manageable with rates in excess of 15% leading to "institutional breakdowns…"[36] [37] [38] [39] [40] [41]

The challenges in local growth and planning facing policymakers and planners in a milieu

of rapid energy growth are often not easily addressed due to residents being unwilling to change or unsure of the best path forward. Jacquet (2009) points to Kassover and McKeown (1981) who provide five policy issues often met with skeptical or negative resident interaction:[42]

> a) Planning the location of growth: do communities strive to locate new housing and economic development around the core existing communities or attempt to direct growth away from communities? b) The use of lead time. The amount of lead time and degree of commitment to social planning will determine the extent to which management programs are in place by the time they are needed. However, planning and policy changes during lead times can be even more controversial as residents may reject changes before the growth has yet to occur. c) Preventive or reactive programs: Advance planning can allow the implementation of preventive programming. However, boomtown experiences indicate that unless funding stipulations emphasize prevention efforts, available resources will be used almost exclusively for reactive programming. d) The selection of a human impact planning organization: Should the planning and advisory authority be vested in an organization external to government and industry? If so, how should that organization be comprised and its authority supported and/or limited? Many residents may view such an outside organization as illegitimate or biased, and a governmental organization as corrupt. e) The allocation of resources: Who bears the cost of coping with human impacts; who determines appropriate expenditures; what is the process for negotiating responsibility?[43]

Perhaps the most contentious community issue related to planning, rapid energy development and resulting population influx is the lack of affordable housing. A recent report from the Pennsylvania Governor's Marcellus Shale Advisory Commission states that "as the gas industry is expanding into communities, housing costs have risen to meet demand such that local residents can no longer afford housing… Some local residents, especially renters, have been forced to relocate further away from their jobs and communities to find an affordable place to live."[44] There is evidence that builders are responding to the needs of the industry and its workers by starting to construct affordable housing near shale gas and shale oil plays.[45]

The escalation in real estate valuation is a double-edged sword, however. While

apartments in Towanda, Pennsylvania that once rented for $400 are now $1,500 a month, in Williamsport, Pennsylvania, real estate has increased in value and the downtown is experiencing a rebirth. Buildings that haven't seen a tenant in years "are becoming upscale restaurants" while many of the new population influx are "purchasing higher-end downtown apartments."[46] [47] Real estate and renting agents take a positive view of this trend as their businesses are booming.[48] [49] Taken into consideration with the rest of the nation's economic malaise, it is hard to argue that escalating real estate valuation is necessarily a negative externality. At the same time as the values are escalating in these communities, people are purchasing homes and moving in – an event that has been rare for many decades. Rising valuations also fly in the face of some anti-drilling organizations that argue (without any statistical evidence to support their claims) shale plays have a depressing impact on overall property values, even in cases where landowners hold the mineral rights.[50] This argument is most prevalent in the Marcellus Shale, but concerns about the negative impacts of drilling on property values have also surfaced in the North Texas Barnett Shale.[51]

Along with issues relating to housing availability and affordability, planners working in areas with rapid energy development must often deal with competing land-use issues. For example, several observers and pundits argue that gas drilling is incompatible with tourism and wine production in the Finger Lakes region of New York State, though they offer no evidence to support these claims.[52] [53] [54] Conversely, in Pennsylvania researchers examined the tourism industry (tour operators, souvenir stores, tourist attractions, and retail stores – including bike shops and sporting goods stores that carry hunting equipment) in two counties affected by drilling in the Marcellus Shale and found that:

> About 29 percent of these tourism-related businesses said that their sales have increased due to natural gas drilling activity, while the other 71 percent reported that their sales had not changed. None of the tourism-related businesses reported a decrease in sales. Sporting goods and bicycle shops were the most likely to report sales increases. Of those tourism-related businesses experiencing increased annual sales, the majority reported that the gas industry sought out the goods/services their businesses offer. None of the businesses reported difficulties in retaining or finding employees.[55]

Assertions have been made that increases in rental housing and lodging costs will crowd out recreational tourism in the Finger Lakes and as well as locations in rural Pennsylvania that attract tourists and hunters.[56] Similarly, the potentially negative impacts of drilling on forest habitat, wildlife, and wilderness recreation have been the subject of several recent media reports.[57] [58] [59] It is important to note that the unconventional gas drilling industry in the Marcellus Shale is still young, that the "long-term impact on tourism… is unknown," and "additional new well pads, pipelines, and access roads have the potential to change the community enough to affect tourism."[60]

There appears to be no incompatibility of drilling with farming. Indeed, the impact on farmers in the Marcellus has been mostly positive, according to researchers at the Pennsylvania State University Extension Service. Revenues from gas leases have given farmers the opportunity to add or replace equipment, plan for retirement, and attract the younger generation back to the farm.[61] In some cases, drilling is seen as better use for undeveloped land with residents of California and Colorado preferring drilling activity over additional housing developments as it will leave the "wide open spaces still wide open."[62] [63] A lesser discussed issue in relation to land-use planning relates to leases signed with cemeteries in Pennsylvania, though there has been no discussion of how drilling might affect the operations of mortuaries and burials.[64]

Planning for adequate education infrastructure yields both challenges and rewards for a community. The expansion of shale gas and shale oil drilling and extraction and accompanying population increases is, in some cases, placing unforeseen burdens on local public school systems. At the same time, rapid energy development is creating new education and training needs in areas such as well control, waterline operations, casing, cementing, etc. A number of community colleges have developed certification programs to train and retrain workers to perform these tasks.[65]

For an example of what can happen if planning is an afterthought to a modern energy boom town, one need only to look at Alberta, Canada's oil sands play and the city Fort McMurray. Growing from a population of approximately 1,000 during the 19th century to 30,000 in 1996 and an internationally diverse 80,000 today – over 100,000 for the region – the city has experienced most of the negative externalities associated with a rapid influx of population.[66] Despite a lack of engagement with the community and the energy industry in the beginning stages of this boom, planners and policymakers alike are addressing this growth and quickly playing catch-up to try and mitigate circumstances involving everything from astronomical real estate valuations to astonishing highway fatality levels to health care inadequacies. This monumental lack of foresight is tempered by a booming industry and a provincial government now facilitating an equally booming staff of urban planners eager to make the city a "model of sustainability." With policymakers, industry, and the community working together, there is a brighter future ahead for Fort McMurray. It may not come overnight, but it will develop in tandem with an area referred to as "the energy capital of North America."[67]

It is easy to suggest planning as an important element when discussing a community's transition from a former self into an energy extraction hub. What is more difficult is funding the planning and mitigation necessary to facilitate this transition. Rapid energy development comes with infrastructure, social, and environmental costs. While unconventional oil and gas drilling offers huge fiscal windfalls to the communities hosting the drilling (as the follow section will detail), sometimes these windfalls are not realized quickly enough or distributed evenly across all of the areas affected by drilling activity. One way to help address the local costs associated with natural gas extraction might be imposition of a severance tax. But critics of a severance tax offer that such a tax might deter the unconventional gas and oil drilling industry from establishing a presence in affected areas.

Another option might be a dedicated impact fee levied per well and funneled directly back into local communities. In October 2011, the governor of Pennsylvania outlined an impact fee program that would address both local and state burdens and take into consideration municipalities directly affected by drilling and those that experience ancillary effects from neighboring activity:

> The Corbett fee would be imposed and collected by counties. It would place a $40,000 levy on wells during their first year of production. That number would drop to $30,000, and then $20,000, during the second and third years. From year four through ten, energy companies would pay $10,000 per well… counties to keep 75 percent of the revenue… The county itself would keep 36 percent of that haul, give 37 percent to municipalities hosting wells, and distribute its remaining 27 percent to its townships *without* natural gas drilling... The rest of the money… would go to the state. PennDOT would receive the bulk of the cash, for use on infrastructure repairs in drilling counties. PEMA, the State Fire Commissioner, Department of Health and Public Utility Commission would each receive shares of less than ten percent, and the Department of Environmental Protection would take a 10.5 percent cut.[68]

In a country with over 300 million people, a viable energy source can be both a necessity

and a commodity. The ability to identify and quickly retrieve natural resources that help power our nation and keep it competitive globally is important nationally and in the community. Unlike the boom towns of our mineral extraction past, today's shale plays are in some cases part of a multi-dimensional plan for economic development; in other cases, a cause for alarm offering the raw materials for planners to create a better community. Will the Williamsport and Fargo of today be the Park City and Denver of tomorrow? Will Fort McMurray be a new international paradigm altogether? It may be too soon to tell; but with the unconventional oil and gas drilling industry creating scenarios like a $1 billion surplus in the North Dakota state budget and corresponding population growth not seen in decades, planners, policymakers, and the energy industry must work together to improve communication and manage perceptions.[69] [70] North Dakota Governor Jack Dalrymple stressed the importance of this cooperation during a nationally televised interview:

> Part of the challenge here is for the state to develop policies that keep up with that pace of development, and that's why we've worked really hard at putting extra money into state highways out here. We've actually given money directly to counties and townships to help them with their infrastructure – absolutely unprecedented in state history. And we have a large grant program that goes directly to cities to allow them to develop their housing out here. So, it is part of the state's responsibility to stay ahead of the development; if you don't, then the whole thing comes crashing down.[71]

With attention to planning and responsible development from all parties, the unconventional oil and gas plays of today can create communities that will become as iconic and thriving as those sprouting from the booms of times past.

II. Economic and fiscal benefits and costs from shale gas/shale oil development

The economic and fiscal impacts on communities associated with rapid energy development have historically been difficult to predict and measure. Boomtowns of the past often relied on a single section of an environmental impact statement detailing potential economic impacts as a guide. Researchers subsequently developed models attempting to explain and predict changes a community might encounter but met with mixed results (Jacquet, 2009).[72] Variations among regions and differing dynamics of local economies make predicting the economic and fiscal impacts of energy development extremely challenging. At the same time, expectations of residents and business owners in affected communities often exceed actual results. Based on research examining communities affected by prior rapid energy development, Jacquet (2009) states that resulting economic impacts are "mixed" and "smaller than was originally assumed by community members."[73] The author points to studies by Lovejoy and Little (1977, 1979), Davidson (1979), and Freudenburg (1982) documenting the unsuitability of established residents for newly created energy jobs, comparatively higher failure rates of small businesses in boomtowns, and profits falling short of expectations.[74] [75] [76] [77] However, the author also argues that "communities can overall expect rapid job growth and booming retail trade for businesses that cater to these new residents."[78]

Stakeholders associated with current shale oil and gas plays can now benefit from years of research concerning the economic and fiscal impacts of rapid energy development. Research techniques used to estimate the impacts and costs of rapid energy development continue to mature, making today's studies more accurate in terms of identifying the potential costs and benefits to a community. These reports are the well from which reporters, politicians, and

critics pull the oft-quoted sizeable numbers relating to job creation and overall economic impacts. As such, to gain a better understanding of the role and context of the numbers discussed in public, it is important to sidestep the media's understanding of them and give the reports themselves a closer reading.

These reports often come under fire from those opposing the use of hydraulic fracturing due to funding concerns and the methodologies employed. While it is true that some of the reports are funded by oil and gas industry organizations, they are often authored by non-biased researchers holding academic positions at established universities, with those institutions lending their name and reputations to the finished product. These reports also tend to use input/output economic modeling methodology to estimate economic and fiscal impacts to the communities and regions hosting the drilling in question. Researchers utilize industry standard software such as IMPLAN in order to estimate the primary and residual effects of spending by the unconventional oil and gas drilling industry at local, regional, and state levels.

Despite their use as a way to estimate economic impacts across a wide array of industries, input/output models are often criticized for not being holistic enough in nature to address concerns and costs associated with unconventional oil and gas drilling. This critique does hold value, but it is important to place the use of IMPLAN and associated methodologies in the context of the whole report and consider how the content of the reports is changing over time along with the maturation of the industry. Impact studies have been issued at a rapid pace over the past few years of the unconventional oil and gas drilling boom. What follows is an examination of a representative handful speaking to dynamics and trends of the entire industry.

The first report of interest concerns one of the biggest shale plays, the Barnett, and is representative of the initial flurry of reports associated with it. *Drilling for Dollars: An Assessment of the Ongoing and Expanding Economic Impact of Activity in the Barnett Shale on Fort Worth and the Surrounding Area* authored by The Perryman Group in 2008 looks at the economic impacts unconventional gas drilling has on the Barnett Shale region.[79] The authors estimate that the effects of Barnett Shale activity – based on year-end 2007 levels – are $8.2 billion in annual output, $2.4 billion in annual retail sales, and the creation of 83,823 permanent jobs. These numbers are a more than 50% jump from the authors' previous estimations in 2006.

In addition to economic impacts, the authors examine several other regional effects related to drilling on the Barnett Shale. Since major drilling has started, the region has added 3.93 million square feet of office space, witnessed an increase of over 6 million square feet in industrial space, and 5 million square feet in retail outlets. The authors attribute an increase in demand for 38,100 units of housing over the past few years to activity in the Barnett Shale. Based on year-end 2007 data, tax receipts to state and local governments exceed $1 billion per year with $715.5 million sent to the State and $378.7 million to counties, cities, and school districts.

According to the report, companies operating in the Barnett Shale also contribute millions of dollars and hours of employee time to local charities of many types. Donations in 2007 are estimated at over $6.8 million per year – more than three times 2006's reported numbers, and still only a conservative estimate. The study concludes that unconventional gas drilling is a "major source of stimulus to the Fort Worth-area economy, helping ensure prosperity even in the face of a national economic meltdown." Furthermore, the authors

encourage additional investment in the region's drilling industry in order to stimulate a variety of industries in the region.

Perryman revisits this topic in 2011 and considers the cumulative impacts of drilling in the Barnett Shale over a ten-year period. *A Decade of Drilling – The Impact of the Barnett Shale on Business Activity in the Surrounding Region and Texas: An Assessment of the First Decade of Extensive Development* concludes that the region encompassing the Barnett Shale received a cumulative economic impact of $65.4 billion in total output and 596,648 person-years of employment between the years 2001 and 2011. The Perryman Group estimates that the local fiscal impact in that decade reached $5.3 billion.[80]

The broader picture encompassing ancillary items such as real estate development and charitable giving are often left out of the discourse when considering local and regional impacts. The inclusion of them by The Perryman Group – and in earlier reports issued by organizations such as the Joint Urban Studies Center – foreshadows a much larger consideration of holistic impacts in more recent studies as the unconventional drilling industry quickly matures.[81] By 2009, drilling in the Barnett Shale had become ingrained in the local culture and economics of the Dallas-Fort Worth region. Citizens understand the broad spectrum of benefits to their communities while also appreciating the steps needed to mitigate risk. While there is a stream of studies examining impacts of shale plays in other parts of the country such as the Eagle Ford Shale in South Texas, the West Slope in Colorado, and the Haynesville Shale in Louisiana, the bulk of subsequent economic impact research focuses on the emerging giant of shale plays, the Marcellus Shale.

Although the size of the Marcellus Shale play vastly eclipses the Barnett Shale, and the ease of which the gas can be accessed is much greater, leveraging the Marcellus Shale and its economic potential is much more difficult for two reasons. Unlike the North Texas region, residents of the northeastern United States are not as familiar with the energy industry or the realistic costs and benefits of unconventional oil and gas drilling. Residents may only remember the coal mining industry and its associated economic and environmental failures or at worst televised images of Middletown, Pennsylvania's Three Mile Island threatening to meltdown. In addition, unlike drilling activity in the Barnett Shale, proposed drilling in the Marcellus Shale is preceded by several years of special interest groups promoting polarizing anti-drilling agendas in the media and political arenas. This lead-time has facilitated both positive and negative outcomes.

Economic research concerning the Marcellus Shale benefits from studies completed on the Barnett Shale as measurement and forecasting methodologies are tested and refined. Reports have also become more holistic in nature weighing the true costs of environmental impacts and fiscal policy. Unfortunately, the lead-time has neutralized some of these reports as states like New York have elected to freeze unconventional gas drilling though regulation while other states such as Pennsylvania and West Virginia struggle with public debate and spend considerable time sorting out regulatory and policy issues.

Like reports that detail and estimate the economic and fiscal impacts of the Barnett Shale, reports concerning the Marcellus Shale also contain staggering numbers. *An Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play* issued in 2009 by The Pennsylvania State University and funded by the Marcellus Shale Gas

Coalition takes advantage of the aforementioned lead-time and offers an arguably more accurate modeling technique to estimate the Marcellus Shale's impacts on the Pennsylvania economy.[82] First, the authors use IMPLAN software to develop an input/output model that, compared to several similar studies, uses a higher "multiplier" to estimate the enhanced value each dollar spent by the Marcellus industry has on the Pennsylvania's economy. The authors acknowledge this and justify it by stating, "This study's higher multiplier probably reflects our detailed expenditure analysis based upon company accounting data, which provide a more accurate measure of inter-industry purchases." After estimating the direct, indirect, and induced impacts of the Marcellus industry in Pennsylvania, the authors arrive at a total economic output for it of $4.2 billion. The authors then discount the figure and use a "more meaningful estimate of economic impacts." Their next estimate is "value added, which subtracts inter-industry purchases from gross output and measures the returns to labor and capital." A total economic impact of $2.3 billion for Pennsylvania in 2008 is then offered. This total impact generates 29,000 jobs and $240 million in state and local tax revenue. Projections for 2009 are $3.8 billion in value added, 48,000 jobs, and $400 million in state and local tax revenues. By 2020, the authors estimate that the drilling in the Marcellus Shale would generate $13.5 billion in value added, 174,700 jobs and $1.4 billion in state and local taxes.

A follow-up report was issued by The Pennsylvania State University in 2010 using the same modeling as the prior study, but with complete numbers for 2009.[83] The authors find their estimates for 2009 very close to the previous report's numbers with $3.8 billion in value added, 44,000 jobs, and $389 million in state and local tax revenues. For 2010 and 2011 impact estimates, modeling was in part based on survey results returned by those drilling in the

Marcellus Shale. The value added in 2010 is projected at $8 billion with 88,000 supported by the activity and $785 million in state local taxes generated. The following year is equally robust.

Of note in the initial 2009 report are the authors' concluding insights and policy recommendations wherein they refute the need for severance tax revenue to mitigate environmental damage and other external effects by stating "…the environmental disruptions from natural gas production are minimal… the gains from development in terms of jobs and local tax revenues will likely exceed any adjustment costs or any transitory windfalls from taxing an infant industry…" This line of reasoning is quantified in a report discussed later in this section. A final suggestion is that Pennsylvania lawmakers should also not impose a severance tax on the Marcellus industry as that would lead to substantial losses in fiscal revenue and potentially drive the industry to other natural gas plays – a point also made in other reports examining the Marcellus Shale play.

Another report issued in 2009 addressing the Marcellus Shale is *Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York* penned by a professor at the University of North Texas and the associate director of the Maguire Energy Institute at the Southern Methodist University.[84] Economic and fiscal impact estimates are made over a ten-year period using two scenarios – drilling 2,000 or 4,000 wells. Resulting estimates range from $7-14 billion in expenditures and a total of up to $15 billion in local economic activity. This would support 8,000 to more than 16,000 "person-years of employment" paying an estimated $396 - $792 million in wages. Fiscal revenue generated by the drilling would offer between a $42 and $85 million gain in state and local taxes in this scenario with Broome County receiving roughly half of those figures. Once the wells were built and functioning, there would be

recurring economic and fiscal impacts resulting from ongoing production and maintenance. The authors offer conservative projections of this impact over a ten-year period for both scenarios and estimate equally large numbers in terms of revenues, fiscal returns, and employment. The authors conclude their analysis in much the same manner as the initial Pennsylvania State University report with the suggestion that New York should "avoid the temptation to levy a severance tax on natural gas production" and be careful to not enact "excessive regulatory or fiscal burdens" as they could "significantly limit New York's infant industry." The underscoring suggestion is that the industry could easily move its operations to Pennsylvania.

In 2010, the lead author of the Pennsylvania State University reports turned his attention to the tri-state region of the Marcellus Shale and penned *The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia* – a report made to the American Petroleum Institute.[85] The author examines the economic impacts of unconventional gas drilling in New York, Pennsylvania, and West Virginia in 2009. Results show that wells drilled in Pennsylvania and West Virginia added $4.8 billion in value to the regional economy, generating 57,357 jobs and $1.7 billion in local, state, and federal taxes. The author then considers potential impacts for the tri-state region if the drilling moratorium is left in place in New York, if it is lifted and a "modest" amount of drilling takes place, and if Barnett Shale levels of drilling take place in all three states. Estimated impacts soar when Barnett Shale levels are used. Value added from drilling is $11.9 billion in 2011, reaching $24.7 billion by 2020. State and local taxes increases range from $1.2 billion in 2011 to $2.9 billion in 2020 with employment numbers estimated at 135,939 in 2011 to a projected 282,716 in 2020.

In addition to estimating impacts, the author further contemplates the regulatory

environment that is prohibiting communities in the Marcellus Shale to enjoy the benefits afforded to those in the Barnett Shale region. A comparative analysis among the three states suggests that in addition to the moratorium in New York, the presence of a severance tax in West Virginia is hobbling potential economic impacts. The author argues that an "imposition of any significant severance tax on Marcellus natural gas output could induce a redirection of investment flows to other shale plays or other profitable investments." He then adds, "Any revenues gained from a severance tax could be limited by losses in sales and income tax receipts resulting from lower drilling activity and natural gas production as producers shift their capital spending to other plays." The report closes by suggesting that an abundance of natural gas supplies could attract industry to the northeastern states offering further economic impacts on communities in terms of fiscal revenue and employment. The author also suggests that leveraging the Marcellus Shale may help reduce greenhouse emissions creating a greener climate for the region.

Functioning as almost a companion piece to the last report is *The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009*.[86] Also released in 2010, this report continues the dual focus on the economic impacts of unconventional oil and gas drilling and the political and regulatory atmosphere surrounding the Marcellus Shale play by examining activity in West Virginia. The authors find "economic impact of the Marcellus Shale development in the state in 2009 was calculated to be $2.35 billion of business volume and accounted for the generation of 7,600 jobs." Despite these figures, the authors suggest they could be higher if the state had a more favorable policy climate concerning the industry. The authors note the paradox of state and federal regulations severely

hampering efforts of natural gas producers while, at the same time, the drilling industry continually monitors and improves its environmental track record by responding to citizen pressure. “Collaboration between academics, industry executives, and environmental scientists has led to developments that will mitigate the long run environmental impact of horizontal drilling and hydraulic fracturing,” the authors state before detailing further evidence of West Virginia’s overtly hostile legal atmosphere towards the drilling industry, including the West Virginia Supreme Court’s decision declining the appeal of a $405 million verdict brought against three companies in the industry.

Continuing this thread of a comprehensive examination of economic and fiscal impacts, regulatory impediments, and environmental mitigation costs is *The Economic Opportunities of Shale Development* released in 2011 by the Center for Energy Policy and the Environment at the Manhattan Institute.[87] The report examines the potential the Marcellus Shale holds for New York State if policymakers would lift the state’s de facto drilling moratorium. The authors suggest that the moratorium is preventing the state from realizing over $11.4 billion in economic output. The authors also take into consideration that fact that much of the region the Marcellus Shale encompasses has been hemorrhaging jobs for decades. The authors suggest that lifting of the moratorium may facilitate the creation of 15,000 to 18,000 jobs in the Southern Tier and Western New York regions – areas that lost nearly two to three times that number of jobs between 2000 and 2010. In addition, 75,000 to 90,000 jobs could be created if the Utica shale and southeastern New York areas were opened to drilling. Local and state tax revenues are estimated at $1.4 billion if the moratorium is lifted.

The environmental costs of drilling in the Marcellus Shale play are also quantified. This study examines the number and scope of environmental violations in Pennsylvania then estimates their value on land, water, and air in terms of their amenity values. Results point to the fact that economic damages as a result of environmental impacts are negligible compared to the amount of economic impact drilling offers. This conclusion is based on the estimates that a "typical" Marcellus Shale gas well offers $4 million in economic impacts while environmental impacts as a result of the well in question are valued at $14,000. The environmental impact number is based on publicly published data gathered by the Pennsylvania Department of Environmental Protection from 2008 to 2010 and is "so low because the probability of an environmental event is small, and those that do occur are minor and localized in their effects." The authors add that "environmental problems that have arisen in connection with hydraulic fracturing in no way call into question the soundness of the procedure," and that the problems are a result of "improper drilling and well-casing techniques and defective formulation of cement." In conclusion, the authors state, "The current shale gas drilling moratorium imposes a significant and needless burden on the New York State economy" and suggest that with proper policy and oversight, environmental costs could be managed and potentially mitigated.

Two other recent reports by the League of Women Voter of Pennsylvania and Headwater Economics offer examples of how economic and fiscal impact analyses can be conducted in a comprehensive manner.[88] [89] In both of these studies, the authors address the environmental, infrastructure, and socioeconomic costs associated with unconventional gas drilling. The overarching narrative emerges that if all parties work together and plan accordingly before drilling activity takes place, a more harmonious result will ensue.

Utilizing a cutting edge mixed-methods approach to estimate the economic impacts of the Marcellus Shale in Pennsylvania, the 2011 report *Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009* offers another comprehensive impact analysis.[90] The authors employ a substantial number of qualitative surveys, GIS – an industry standard software package used for geographic analysis—as well as IMPLAN. Because of this mixed-method approach, the authors are able to detail how industry spending affects Pennsylvania communities spatially and through time.

Surveys of landowners are combined with a GIS analysis of land ownership to assess the impacts of leasing and royalty payments. The authors find that much of the revenue is not spent right away but saved for future uses such as retirement. Contrary to a popular critique, the authors do find that a sizeable portion of the land in question is owned by residents in the counties examined or elsewhere in Pennsylvania; however, they do estimate that some of the mineral rights may no longer be owned by residents of the Commonwealth and adjust accordingly for leakage.

The authors surveyed 2,000 local businesses in two counties with high drilling activity. Their results detail the overwhelmingly positive impacts the drilling industry has on their businesses. Also surveyed were almost 500 municipal governments in 12 counties with the highest Marcellus Shale drilling impact. Of those surveyed, 293 responded with only 18% of them (about 53 responses) affirming that unconventional gas drilling resulted in increased tax revenues. On the other hand, 26% of the respondents claimed that municipal costs increased due to drilling in the Marcellus Shale. These findings stand in contrast to previous studies,

which the authors say “had simply estimated those tax impacts without verifying what is actually occurring.”

The final step the authors take is to “look at the economy-wide impacts, modifying the information with results from the GIS analysis and surveys.” When analyzing economy-wide impacts, the authors address the critique that payroll spending often erroneously includes transient, non-resident workers which artificially increases localized economic impacts. Employment data from a Marcellus workforce study were obtained and two scenarios were created. The first scenario has the 37% of workers who are non-Pennsylvania residents spending half of their earning in the Commonwealth while the other scenario estimates the spending at 75%. An IMPLAN input/output model is used to generate the final impacts.

The report finds that the economic impact of drilling in the Marcellus Shale was between $3.1 and $3.2 billion dollars in 2009 facilitating more than 23,000 jobs. These numbers, although arguably more accurate, are somewhat smaller than those of previously published reports. Nevertheless, an impact of several billion dollars and more than 20,000 jobs is staggering. The authors conclude by acknowledging that the report does not address economic aspects of the Marcellus Shale that are “misunderstood or completely unknown.” These aspects include environmental and infrastructure costs, effects of boom-bust cycles, equity considerations, and detailed ownership of mineral rights among other issues. The acknowledgement of these omissions plus the use of mixed-methods for data gathering and analysis offer a reasonable assessment of the economic and fiscal impacts of unconventional gas drilling on communities in the Marcellus Shale.

In early 2011, the City and Regional Planning department of Cornell University issued a report that offers no numbers at all but focuses on the costs that communities should consider as the Marcellus Shale play gains momentum.[91] Fairly standard social, environmental, and infrastructure costs are mentioned, but the report also considers the impact drilling may have on long-term economic development. The authors surmise that drilling may cause competition for labor and raise the cost-of-doing-business for other established businesses causing an atmosphere of "crowding out" that discourages other industries from moving in. They also suggest that drilling activities generate "volatile" revenues resulting in poor planning (i.e. roads, sewer systems, schools, etc. that are unsustainable once the population and activity dwindles) and escalating income inequality. However, the authors acknowledge that a natural gas play is an asset for a community and that if planned for correctly, the community can "invest the infusion of short-term revenues in longer-term economic development" which may "potentially mitigate the effects of the boom-bust cycle and the 'crowding out' phenomenon." It is this last sentiment that cuts to the core of the economic and fiscal impacts offered to communities by unconventional gas drilling. If communities plan ahead, as it is increasingly suggested in impact reports, many costs and negative externalities may be mitigated. Part of this planning includes having detailed impact reports to guide the public, planners, and policymakers.

The speed at which information is analyzed and disseminated is staggering and helps to temper critics as well as encourage responsible industry practices. For example, in May of 2011, an anti-industry critic stated (without any referenced source) that "Reports from Pennsylvania indicate that 70% of its gas drilling labor force is being imported from other states."[92] By August of 2011, the previously mentioned report, *Economic Impacts of Marcellus Shale in*

Pennsylvania: Employment and Income in 2009, found that only 37% of the gas drilling labor force was from outside of the Commonwealth.

In this still early phase of shale plays, economic and fiscal impact reports are primarily estimations, but they are not the baseless exaggerations as critics would lead one to believe. In this section, we have briefly detailed the reasoning and thought behind a representative handful of these reports in order to illustrate the growing sophistication of the methodologies used and the increasingly holistic consideration of the industry's impacts, economic and otherwise.

The amount of money flowing into communities undergoing rapid energy investment is considerable. At a time when much of the country is suffering from economic stagnation, cuts in public expenditure, and sizeable job losses, communities playing host to the unconventional oil and gas drilling industry are in an enviable position. Whether it is the library in Louisiana that was able to pay off its bonds two years early and continue constructing a new branch, the new two-week shale exploration certification program that affords Pennsylvania residents the skills to earn $60,000 to $70,000 a year, or the fact that once withering towns in North Dakota are again hubs of economic activity, shale plays are one of the few bright spots in today's challenging economic landscape. [93] [94] [95]

III. Shale gas/oil and alleged negative environmental and health impacts

As with other types of mineral extraction, drilling and producing gas and oil from shale deposits involves some degree of environmental degradation. Service roads have to be built, some removal of trees and topsoil may be necessary, and trenches may be required for the laying of gathering lines in a producing field. However, responsible drilling companies make efforts to minimize these disruptions and restore the drill sites to their previous condition once the rig moves on — which is usually within two months.

Of all the issues surrounding shale gas and shale oil drilling and production, assertions of negative environmental and health impacts have received the most attention by both researchers and journalists. Hydraulic fracturing is perhaps the most contentious issue. For example, several citizens groups in New York State opposed to gas drilling are highly critical of the proposed regulations from the state Department of Environmental Conservation claiming they are not comprehensive and won't protect communities from both ground and surface water contamination.[96] [97] Some Native American groups are also objecting to drilling and hydraulic fracturing on tribal lands.[98] Not surprisingly, the media jump on those rare occasions when surface water contamination occurs, though reporters don't often distinguish between the drilling/fracking process itself and improper drilling fluid disposal or failures in the casing of wells which has caused water pollution in a handful of cases over the past 30 years.[99]

A number of newspaper articles and editorials have appeared over the past several months claiming that natural gas drilling and hydraulic fracturing have contaminated well water, but documentation to support these claims is absent.[100] [101] [102] Even the *New York Times* story claiming that hydraulic fracturing led to pollution of a well in West Virginia in 1984

acknowledges that the EPA has reached no conclusion as to how the fluids moved from a depth of 4,200 feet, where the well was fracked, to the water well about 400 feet underground.[103] At the same time, research by *Politifact* and others has supported claims that no evidence of groundwater contamination related to hydraulic fracturing has been found since the technology was first used in the 1950s.[104] [105]

Another recently expressed concern with hydraulic fracturing is that it may precipitate earthquakes. Indeed, the state of Arkansas has banned drilling in certain earthquake prone zones as a result of seismic activity that occurred earlier this year, though the culprit is thought to be wastewater injection wells in parts of the Fayetteville Shale. [106] The U.S. Army Corps of Engineers is studying whether increased geological pressures from fracking could cause shifts along natural faults, thereby weakening dam foundations, and has declared a 3,000-foot buffer within which it will not allow drilling, fracking or pipelines.[107] In 2008, several small earthquakes were detected near Dallas-Fort International Airport where a number of gas wells had been drilled. But subsequent geological analysis found that this seismic activity was likely caused by fluid injection into disposal wells and not hydraulic fracturing.[108] Allegations have also been made, though discredited, that the large August 2011 East Coast earthquake was caused by the compounding impacts of hydraulic fracturing.[109] [110]

Water availability and wastewater disposal also loom large as perceived environmental negatives with shale gas and shale oil production. Most reports estimate it takes between two and 13 million gallons of water to frac a single well, depending on the type of rock formation being penetrated.[111] [112] During periods of normal rainfall, water supply may not be an issue. But during a severe and prolonged drought, as is now the case in Texas and other Southwestern

states, access to water may become problematic with drillers and farmers competing for a scarce resource. [113] [114] [115] The General Accountability Office recently issued a report expressing concern about the water demands from oil shale development beneath federal lands managed by the Department of Interior's Bureau of Land Management.[116]

As for wastewater disposal, many communities — but especially those located in the Marcellus Shale — are concerned about potential environmental damage, even when the wastewater and other fracking fluids are disposed of properly.[117] [118] [119] One commentator argues that wastewater disposal and public perception may become the two Achilles' heels that will stymie future shale gas and shale oil plays.[120] At the same time, however, the industry is developing new processes to treat and recycle water.[121]

Air pollution and methane migration also crop up in news articles about the dangers of shale gas drilling and production. For example, an article in a Colorado newspaper claims that toxic chemicals were detected in the air near drilling sites.[122] Similar allegations were made about VOC emissions from drill sites in and around Fort Worth, Texas.[123] However a study by the Texas Commission on Environmental Quality found no significant negative health effects or air pollution from drilling activities in the city.[124] Nonetheless, allegations persist of air pollution from drilling in the Barnett and other shale plays.[125] [126]

A recent study of the "life cycle" of greenhouse gas emissions from shale gas production, transportation and end use in the Marcellus found that the carbon footprint was 20 to 50 percent less than coal.[127] In Colorado, state regulators recently found high levels of hydrogen sulfide gas at several rig sites while an anti-drilling group claims it detected at least 22 toxic chemicals, including four known human carcinogens, in nine separate air samples taken

near natural gas drilling operations in Garfield and La Plata counties in Colorado and the San Juan Basin of New Mexico.[128]

Methane migration into drinking water is another controversial issue pursuant to hydraulic fracturing. Anti-drilling advocates claim this is a serious problem that occurs with great frequency.[129] On the other hand, a recent study by the Pennsylvania Department of Environmental Protection, conducted in response to claims that water wells were being polluted by migrating methane from shale drilling, found no elevated methane in private drinking water wells in Susquehanna County.[130]

Other health issues have been raised with regards to shale gas/shale oil drilling and hydraulic fracturing. For example, a blog post in July 2011 claimed that children at summer camps in Pennsylvania and New York were being exposed to carcinogens from hydraulic fracturing.[131] Traces of EDB, a chemical used in pesticides and a known carcinogen, have turned up around Denton County, Texas drill sites, though it's not clear that its presence is related to drilling or production.[132] And according to a recent report from the Centers for Disease Control, the incidence of breast cancer has been rising in North Central Texas counties with shale production, in contrast to the national rate which has been declining, though no causal link has been established.[133] A consumer advocacy group in Colorado is claiming that fracking has caused livestock and crops to die from tainted water, people in small towns to endure severe headaches and blackouts, and flames to explode from kitchen water taps.[134]

Few scientific studies have been conducted on the long-term health effects of shale gas and shale oil exploration and extraction on people living and working in the vicinity of these activities. But a 2008 review of research reports between 2003 and 2008 prepared for the

Natural Resources Defense Council (NRDC) concludes that people in close proximity to oil and gas activities ***may*** be at increased risk for cancer, cardiovascular disease, asthma, and other disorders related to exposure to air pollutants, toxic chemicals, metals, noise and radiation.[135]

Drilling and hydraulic fracturing are also being blamed for killing trees and foliage around pad sites. One study by the U.S. Forest Service found that the application of hydrofracking wastewater to a forest in West Virginia did enormous damage to the forest ecosystem, killing all ground plants and many trees.[136] Gas drilling has also been fingered as a possible culprit in tree deaths near drill sites in Denton, Texas, though the record heat wave and drought of the summer of 2011 is a more likely cause.[137]

A final environmental issue receiving a great deal of attention is public disclosure of the contents of fracturing fluids. Arkansas, Louisiana, Texas, Pennsylvania and Wyoming have already enacted regulations or laws requiring such disclosure, and the matter is being considered in several other states as well.[138] Chemical disclosure is also being advocated by the Energy Advisory Board of the U.S. Department of Energy.[139] At the same time, a recent article in *Popular Mechanics* magazine emphasizes the safety of hydraulic fracturing and debunks many of the assertions of negative environmental and health consequences from use of the technology.[140]

IV. Infrastructure and pipeline concerns with shale gas and shale oil development

A review of the literature on the effects of rapid energy development on local infrastructure indicates that deterioration of roads, highways and bridges is the primary concern. A secondary concern is pipeline construction with attendant right-of-way and safety issues.

The road deterioration issue appears to be especially acute in the Pennsylvania Marcellus. A report from the Pennsylvania Department of Transportation claims that hundreds of bridges are rusting while many roads and highways are in serious disrepair in part because of an increase in Marcellus-related heavy truck traffic. The report further estimates the cost of repairing the state's bridges and highways at close to $9 billion.[141] To relieve some of the heavy truck congestion on secondary roads, the state is attempting to secure funding for a Central Susquehanna Valley Thruway.[142] Pennsylvania has also proposed to allow local communities to assess "impact fees" on the natural gas industry to help pay for road repairs.[143] The impact fee proposal is likely a response to a study from Pennsylvania State University arguing that the current road bonding amount of $12,500 per mile is too low to cover repairs.[144] Allegheny Township, in the heart of the Pennsylvania Marcellus, may adopt additional road standards that will require gas well drillers to repair damage as it occurs rather than wait until the well is completed.[145]

New York State, which has yet to see much drilling in their part of the Marcellus, is nonetheless examining the potential impact of shale gas on the state's road system. A "leaked" document from the New York State Department of Transportation, dated June 22, 2011, estimates road and highway damage between $121 million and $222 million per year if shale

gas development goes forward.[146] The report concludes there is no mechanism in place allowing state and local governments to absorb these additional transportation costs.

Some of the major drilling companies in the Marcellus Shale are voluntarily paying for the repair and upgrading of roads affected by heavy truck traffic. For example, Chesapeake Energy spent $30 million in 2010 on road improvements in Lycoming, Sullivan, Bradford and Tioga counties in Pennsylvania while Anadarko Petroleum spent $1.3 million to upgrade a state highway in the Pine Creek Valley.[147] Chesapeake also recently announced it will spend tens of millions of dollars on road repairs around their West Virginia drill sites.[148]

A variety of concerns have been raised regarding pipelines including safety, construction and eminent domain. At present, pipeline companies are required to perform periodic water-pressure tests on all transmission lines built after 1970. But the Pipeline Safety and Hazardous Materials Administration (PSHMA) may soon mandate such testing on 178,000 miles of high-pressure, large-diameter gas pipelines built before 1970.[149] These lines represent about 60 percent of the nation's network. The 2010 pipeline rupture and explosion in San Bruno, California that killed eight people, and the pipeline break under the Missouri River in August 2011, have likely prompted PSHMA to consider this policy change.[150] [151] Debate over the proposed Keystone XL pipeline project that would bring bitumen from the Alberta oil sands to refineries on the U.S. Gulf Coast has also focused both public and media attention on pipeline safety.[152]

Other accidents have directed regulators' attention to pipeline safety, though in most cases the ruptures and fires have occurred on distribution lines, not transmission lines.[153] [154] Several members of the Pennsylvania legislature plan to introduce legislation that would extend

state pipeline regulation to include gathering lines, allegedly to ensure they are properly marked so as to avoid accidental breaks during excavation.[155]

In some cases, the siting of pipelines and compressors results in community pushback. For example, several drilling companies in the Pennsylvania Marcellus have had difficulty obtaining the requisite zoning changes from local townships for the installation of compressors, metering stations and chemical tanks because of proximity to schools and other public venues.[156] Though pipeline companies usually have powers of eminent domain either from FERC or from the states, right-of-way controversies have cropped up in many fast-growing shale plays, especially in more densely populated communities.[157] The result has been a huge increase in condemnation lawsuits. For instance, pipeline companies in Pennsylvania filed 61 lawsuits in 2009 compared with 16 in 2008. During the first eight months of 2011, pipeline companies filed at least 184 lawsuits against landowners in the south Texas Eagle Ford Shale ahead of a change in the state's eminent domain statute that took effect on September 1.[158] The new law will make it harder to condemn land for easements by requiring entities with eminent domain authority to make a good-faith effort before filing suit while giving landowners more time to respond to offers.

V. Conclusion

As our review of the literature has shown, rapid energy development creates new economic opportunities for nearby communities in terms of jobs, income and tax revenue. In some cases, as with North Texas and Central Pennsylvania, oil and shale gas exploration, drilling and production have added an entire new dimension to the local economy. However, as the discussion above suggests, these economic growth opportunities, and the companies involved with energy development, are not always warmly welcomed by some members of the local community. Local concerns may relate to perceived negative environmental and health impacts, more competition for local labor, housing shortages, noise, and traffic congestion. What's more, these concerns tend to be amplified when drilling activity moves into built-up areas.

Some regional differences can be detected when it comes to local "push-back" against shale gas development in that anti-drilling sentiment seems to be greatest in areas of the country that don't have a recent economic history with mineral extraction. This has certainly been the case in Pennsylvania and New York, though ironically Titusville, Pennsylvania is where America's oil and gas industry was born. By contrast, the shale-energy revolution has been mostly welcomed in the Southwest, Southeast, and North Dakota, areas where mining has been an economic activity for a century or more.

As mentioned at the outset, much of the "conventional wisdom" regarding the negative social and environmental impacts from rapid energy development is based on opinion and conjecture and not necessarily the "facts" of the matter. These perceptions, right or wrong, are

then disseminated by local media to the general public, often by reporters who are not familiar with the procedures and technologies utilized in extracting oil and gas from shale formations.

Nonetheless, claims and assertions, even if incorrect, may serve to shape a community's view of how energy development is affecting (or will affect) their environment, social fabric, and overall quality-of-life. Land men and drilling companies need to be sensitive to these concerns, be they real or imagined, and work continuously at improving communications with landowners, local officials, and the general public.

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