A Case Study and Cost-Benefit Analysis of Hydraulic Fracturing
in Williams County, North Dakota

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Introduction

Hydraulic fracturing, or fracking is the process of extracting oil and gas from underground rock formations, most typically shale, by pumping a pressurized mix of water, sand, and chemicals into the rock formations. The sand is used to keep the fractures open, leaving space for the gas and oil to pass into the well. The first commercial application of the fracking technique invented by Floyd Farris and J.B. Clark occurred in 1949\(^1\), but it was not widely used until the 1970s. The introduction of horizontal drilling in the 1980s created a surge in fracking activity because it became possible to extract oil and gas from horizontal rock formations that are relatively thin. Previous vertical wells had not been economically viable because they could only extract gas from a roughly 100 foot wide span of the thin horizontal formations.\(^2\)

Oil and gas extraction through fracking is the dominant method of on-shore drilling in the U.S. On a national level, fracking has greatly reduced U.S. dependence on imported energy resources. For fracking boom towns, the local economy is stimulated through increased tax collections, infrastructure investment, consumer activity, housing, and employment, especially for uneducated workers. For corporations, fracking is a simpler technological process and provides higher profit margins compared to deep water wells.\(^3\)

Despite the economic benefits, fracking comes with significant downsides. The influx of workers during the fracking boom has contributed to a variety of social impacts, including increased cost-of-living and crime rates. It is still widely debated, but in addition to the

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\(^1\) American Oil and Gas Historical Society. A “Fracking” Industry.
\(^2\) Brady, Jeff. Focus on Fracking Diverts Attention from Horizontal Drilling. January 27, 2013.
societal impact, fracking is thought to contribute to water contamination, air pollution and damage to ecosystems.

This paper discusses the effects of fracking in a single municipal area, Williams County, North Dakota, to provide a comprehensive overview of the fracking impacts on the county and state economy, environment, and community. We conduct a cost-benefit analysis of the practice of fracking in that county to determine if the economic benefits outweigh the social and environmental costs.

**Focus on Williams County, ND**

Our analysis focuses on North Dakota because of the Bakken shale formation that spans 200,000 square miles under western North Dakota, Montana, and Saskatchewan, Canada. According to the U.S. Geological Survey conducted in 2013, the Bakken shale formation has more recoverable oil than any other known shale formation in the U.S., estimated at a total equivalent of 7.38 billion barrels of oil. According to the Energy Information Administration, the Bakken accounted for 90% of North Dakota’s oil production. North Dakota had stagnate economic activity prior to the “fracking boom” that began in 2007, leading to growth in the oil industry, construction, trucking and services industry jobs. The new economic activity has made North Dakota gross domestic product (GDP) the fastest growing in the nation since 2008. In 2012, North Dakota surpassed

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4 It was first discovered on North Dakota land owned by a farmer named Henry Bakken.
7 State GDP is calculated as the sum of incomes earned by labor and capital and the costs incurred in the production of goods and services. It includes the wages and salaries that workers earn, the income earned by sole proprietors and partnerships and corporations, and taxes on production and imports—such as sales, property, and federal excise taxes. National GDP is calculated as the sum of spending by consumers, businesses, and government on final goods and services plus investment and net foreign trade.
Alaska and became the second largest oil and gas producing state after Texas. Since fracking began, North Dakota’s economy has grown three times faster than the economy in Texas, which also saw significant increases in fracking operations at the Eagle Ford and Permian formations.

Within North Dakota we specifically focus on Williams County to examine the economic and social impact of fracking at the community level. Williams County is currently the fourth largest oil and gas producing county within the state, but has a larger population and local economy than the top three counties. McKenzie, Mountrail, and Dunn County, the top three producing counties, are scarcely populated and do not present an interesting case for analysis of the social and environmental factors of fracking. McKenzie County, the top producer, has a population of 6,000 despite an 88% population increase in its largest city from 2010-13. In the same time period, Williston, the seat of Williams County, grew by 41% to 20,850 inhabitants making it the fastest growing micropolitan area in the nation. In applying the analysis directly to Williams County we examine the interplay between the economic outcomes of fracking alongside community changes.

**Historical Overview of Fracking in the Bakken Formation**

As noted above, the oil and gas reserves in the Bakken could not be extracted economically through vertical drilling. The rock formation covers 200,000 square miles,

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8 As per U.S. Census, the largest town in McKenzie County, Wartford City, saw an estimated 88% increase in population between 2010 and 2013 (largest % increase of population in North Dakota) from 1,744 to an estimated 3,284.
10 Williston Economic Development.
but is only 90 feet at its thickest.\textsuperscript{11} The oil lies in vertical pockets, separated by 20 to 200 feet of rock that does not produce or contain oil. If a vertical well misses one of these pockets, the well will produce too little to warrant leaving it open, or nothing at all. In horizontal drilling, the well passes through many pockets, allowing the oil to flow into a single pipe. When using vertical drilling, as many as three quarters of the wells drilled were unsuccessful.\textsuperscript{12} In comparison, the North Dakota Petroleum Council reports a 99\% success rate of horizontal wells in the Bakken area (although they define a success as a well that produces any amount of oil, not necessarily a return on investment).\textsuperscript{13}

Continental Resources, now the largest producer in the state, completed their first well in 2004. By 2006, 63 wells had been drilled in the Bakken, each costing $2.2 to $4.5 million dollars, but only nine of them had the potential to return their investment.\textsuperscript{14} In the same year, however, the Parshall oil field, located in the Williston Basin, was discovered which contained several oil-rich layers.\textsuperscript{15} Following the discovery a boom in oil and gas extraction activities started in 2007. As of 2013 well construction cost estimates stood at about $10 million dollars in the Bakken region, compared to $7 million in Texas. Each well was expected to generate $20 million in profits, about $4.4 million in taxes, $1.6 million in salaries and wages, and $7.6 million in royalties.\textsuperscript{16}

\textsuperscript{11} Fillooln, Michael. \textit{Guide to Oil and Gas Plays in North America: Williston, Bakken and Three Forks}. Investopedia.
\textsuperscript{12} A Brief History of North Dakota Oil Production. \textit{The Start of Horizontal Drilling in North Dakota in 1987}. May 14, 2011.
\textsuperscript{15} Williston Basin, rich in deposits of petroleum and potash, covers eastern Montana, western North Dakota, South Dakota, and southern Saskatchewan. Prior to 2006, oil and gas interests focused on Montana.
The state of North Dakota adopted several tax reduction policies in 2008 in order to attract oil and gas companies to the area. The state lowers the extraction tax from 6.5% to 4% of the gross value of recovered oil for all producers in the state if the average price in North Dakota (the monthly average of the daily closing price for a barrel of WTI crude oil minus $2.5) drops below the “trigger price” – an index based on the WTI price. In addition, a 2% tax rate is applied on the the first 75,000 barrels of oil within the first 2 years of horizontal drilling if the oil price is above the trigger price, or for the first $4.5 million of gross value at the well. The 0% tax rate is applied if the price drops below the trigger price, or if the well qualifies for a stripper exemption when production goes below 30 barrels per day. The tax reductions led to a dramatic increase in the number of wells in the Williston Basin and shifted the drilling activity from Montana to North Dakota.

Production and Sales Volume

The current Bakken oil boom is five times larger than the Bakken oil boom in the 1980s.17 On a barrel per day basis, North Dakota oil production reached 12% of U.S. total in August 2014, and the combined oil production of Texas and North Dakota accounted for 48% of the total U.S. production since 2011.18

Between January 2007 and August 2014 oil production in Williams County has increased 1,283% at a compound annual growth rate of 46%, and gas production increased 351% at a compound annual growth rate of 20%. During this period, the share of Williams County in national oil production grew from 0.2% to 1.6% of U.S. total production.

17 Federal Reserve Bank of Minneapolis memo on Demographic, Economic and Financial Activity in the Bakken region, page 1.
18 Perry, Mark J. “Texas and North Dakota Together Now Produce Almost 50% of US Oil, and Would Rank No. 5 Globally as Separate Oil Nation.” Editorial. Carpe Diem, American Enterprise Institute, July 6, 2014
Production of natural gas as a percentage of U.S. total gas production grew from 0.11% to 0.28% of U.S. total production.

The number of active rigs in Williams County peaked in 2012 at 218 rigs\textsuperscript{19}, but as of late November 2014 that number stood at 191.\textsuperscript{20} The decrease in rig count is accounted for by the increase in pad drilling, where a single rig drills an average of four wells in one location. In 2013, two thirds of the drilling permits issued were for multi-well pads.\textsuperscript{21} As of 2014, there were 49 operators in Williams Country producing oil and gas on a total of 1,655 wells. The following six operators have approximately 69% of the market based on production volumes: Continental Resources, Hess Bakken Investments, Oasis Petroleum North America, Statoil, Kodiak Oil & Gas, and XTO Energy. All of these companies are public and are listed on the New York Stock Exchange, except XTO Energy, which is a subsidiary of ExxonMobil. A breakdown of the production of the top 20 operators in Williams County is provided in the appendix.

Using prices from the Energy Information Administration reported for June 2014 of $4.79 per thousand cubic feet (MCF) of natural gas (imported) and the spot price of $105.79 for barrel of oil, the following total value amounts of oil and gas produced in that month were obtained and used to approximate the total annual size of the market, assuming June 2014 production volumes are maintained.

Production Volume and Total Value of Oil & Gas Produced in North Dakota

<table>
<thead>
<tr>
<th></th>
<th>June 2014</th>
<th>12 month projection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production</td>
<td>Revenue ($)</td>
</tr>
<tr>
<td>Oil</td>
<td>32,778,524 BBL</td>
<td>3,467,640,054</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$3,647,718,336</td>
</tr>
</tbody>
</table>

Production Volume and Total Value of Oil & Gas Produced Williams County

<table>
<thead>
<tr>
<th></th>
<th>June 2014</th>
<th>12 month projection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production</td>
<td>Revenue ($)</td>
</tr>
<tr>
<td>Oil</td>
<td>4,703,607</td>
<td>497,594,585</td>
</tr>
<tr>
<td>Gas</td>
<td>6,628,644</td>
<td>31,751,205</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$529,345,789</td>
</tr>
</tbody>
</table>

Sources: EIA.gov, North Dakota Department of Mineral Resources data

Impact on the State and Local Economy

Growth in North Dakota Economy

In 2013, North Dakota’s GDP grew by 9.7%. Of that increase, 3.61% came from mining, primarily fracking operations. The state’s per capita real GDP also rose to 40% above the national average making it the second-highest per capita real GDP at $68,804, second only to the District of Columbia.

The North Dakota Department of Mineral Resources estimates that the number of oil industry jobs in the state will top 60,000 within the next five years. The majority of the jobs have been created directly in the oil industry, but the original lack of construction and infrastructure for oil and gas transportation out of ND has led to increasing economic activity in other industries. From August 2012-13 there was a 23.1% increase in mining

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jobs, 5.9% increase in construction jobs, a 4.7% increase in warehousing, manufactures and utilities jobs, a 7.7% increase in financial service jobs, and 5.6% increase in business service jobs. A breakdown of employment trends is included in the appendix. As of 2014, North Dakota had the lowest unemployment rate of any U.S. state at 2.8%. Total tax collections in North Dakota increased from $1.8 billion in 2007 to $5.3 billion in 2013, from 6.1% to 10.7% of real GDP.

**Growth in Williams County, ND**

Economic activity in Williams County, ND has grown steadily since 2008. In fact, the unemployment rate in the Bakken area specifically is 1.8%, lower than the national unemployment rate of 5.9% as of September 2014. As production would begin to plateau, the number of technicians and permanent positions related to oil production will continue to increase, while drilling and fracking jobs will most likely decrease.

At the end of the first quarter in 2012, Williams County and the other areas in the Bakken Shale Formation had a 19% real increase in average wages from a year earlier, compared to only 4% for the rest of ND. Median household income in Williams County was $69,617 in 2012, above the state median income of $51,641. In addition, the percent of people in Williams County below the poverty line has dropped to 8.1%, 4% lower than the state and 6.4% lower than the national level.

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26 United States Census Bureau. *2013 Annual Survey of State Government Tax Collections*
28 Federal Reserve Bank of Minneapolis report.
Ripple Effects of the Oil and Gas Boom

There has been an established ripple effect in unemployment and wage growth from the Bakken Shale across North Dakota directly correlated with distance from the shale deposit. Counties closer to the shale deposit have lower unemployment and higher wages. Prior to 2004, there was weak correlation in wage growth and it was not until 2009 that the wages in counties within 100 miles of the Bakken Shale separated from the counties further away. The unemployment ripple effect is stronger and can be seen as far as counties 300-400 miles away. There is also a confirmed inverted relationship between average growth in sales taxes for a county and distance from a Bakken county. The farther from the Bakken, the slower the average growth in sales tax, although this relationship was weak prior to 2007. To accommodate the fracking boom, the transportation, construction and services industries have been significantly impacted by the growth.

Infrastructure

A major problem facing Williams County is the transportation of exports, especially produced natural gas. In August 2014, 10% of extracted gas was burned at the well, and 16% further in the supply chain due to limitations in pipeline capacity. In June 2014 however, regulators approved an investment of $2.6 billion by Enbridge Energy Partners to construct a 600 mile pipeline that would move oil to Clearbrook Minnesota starting in 2016 to transport 225,00 barrels per day. Energy Transfer Partners and Enterprise Production

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31 Federal Reserve Bank of Minneapolis report.
32 North Dakota Pipeline Authority. MONTHLY UPDATE AUGUST 2014 PRODUCTION & TRANSPORTATION. By Justin J. Kringstad. 2014.
Partners L.P. also announced investments, making possible the transfer of an additional 885,000 barrels per day upon completion.\textsuperscript{34} Another reason for the inability to deliver all extracted gas to consumers is the lack of liquified natural gas (LNG) plants in the area which makes necessary the use of roads and railways to transport gas in the liquid form instead. Oil, on the other hand, is easier to transport by trucks and rail, but the fleet of trucks is limited and transportation through railroads is expensive as well as potentially dangerous. After the 2013 Lac-Megantic rail accident in Canada, regulatory changes banning transport of oil by rail were discussed.\textsuperscript{35} Despite these discussions, oil is still being transported by rail from North Dakota. The North Dakota government passed a bill in February 2013 that made $720 million immediately available for work on state highways and roads.\textsuperscript{36}

The increased demand for oil transportation has limited the ability of farmers to transport grain out of state. Rail congestion could cost farmers more than $160 million because a local oversupply of grain has lowered prices. Farmers are also projected to lose $67 million in revenue from wheat, corn and soybeans from January to mid-April 2015. Around $95 million more in losses are expected if farmers are unable to move their remaining inventory of crops.\textsuperscript{37} As a result of the fracking boom agriculture dropped to second largest industry in North Dakota by its contribution to GRP.

\textsuperscript{34} Ibid.
Housing

All of the new employees, including temporary workers need accommodation. The majority of the transient men live in housing compounds called man camps. Some of these man camps are not equipped with electricity or running water. The largest “man camp” is Tioga Lodge in Tioga, around 6 miles from Williston which supplies each tenant with a white walled room with a microwave, a TV, a DVD player and a mini fridge.\(^{38}\)

The median house prices in Williams County have grown steadily, although national average has been decreasing since 2012.\(^{39}\) According to the Federal Reserve, housing values and rental rates are increasing faster in the Bakken than in the rest of North Dakota. In 2007-11, rental vacancy rates remained relatively low (4%) in the Bakken. With income rising along with housing costs, the percent of households experiencing burdensome housing costs (greater than 30% of income) was generally low and stable in the Bakken. Housing burdens for renters and owners with income in the $20,000-$35,000 range, however, are diverging steadily. The potential market for new housing units has been estimated at 14,000 total units. An adjusted Renaissance Zone Act came in effect in 2009, aiming to provide property tax reductions to individuals and corporations making “qualified” investments in real properties in the designated Renaissance areas, such as the city of Williston in Williams County. An individual taxpayer who purchases or rehabilitates a residential property is exempt from up to $10,000 of personal income tax for up to 5


years. This applies to corporate taxpayers as well. Single-family residential properties, as well as buildings, structures and improvements for business and investment activities, are partially or completely exempt from property taxes for up to 5 years if the property, purchased or rehabilitated, was designated as a zone project.40

Construction activity has been going on in each of three private development sectors: apartments, single-family homes, and commercial real estate41, however, many workers are living in temporary settlements. One reason for that has been the inability to meet the demand for new housing. For example, the construction industry encountered difficulties with timely supplies of concrete and other building materials.

**Banking**

Historically, growth in construction and land development loans (loans secured by real estate to fund land improvements and construction) in the Bakken area has been similar to the rest of North Dakota. According to the Federal Reserve, however, between 2010-12 construction and land development loans in the Bakken area increased 124%, from $79 million to $176 million, while decreasing 9% in the rest of North Dakota. Total deposits of banks in the Bakken area have also increased substantially since 2010 compared with the rest of North Dakota. Residential real estate loans from Bakken banks began increasing more rapidly in 2010, compared with those banks in North Dakota outside of the Bakken area, and have continued to increase. Profitability for Bakken banks has picked up recently relative to non-Bakken banks.

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Healthcare

Williston’s only hospital has seen emergency room visits increase 50% in a year and now has average wait times of at least 2 hours – even after a $25 million expansion that doubled the emergency ward. Overworked hospital staff turn away 30% of the requested medical services each day because there are not enough health care providers.

Distribution of Fracking Revenue

Corporate Revenues

The six largest operators in Williams County are all public companies listed on the New York Stock Exchange. The chart below shows their total 2013 revenues, profit margins, and their June 2014 production volumes in Williams County. It follows from the chart that many of them continue to experience very high growth in Williams County. For example, ExxonMobil’s announced 38% annual growth in their Bakken operations in the their investor presentation and earnings call for the third quarter of 2014. Based on June 2014 production volumes and prices, some companies are expected to produce more in Williams County in the next 12 months, than their total 2013 revenues. As shown below, little of this revenue directly benefit the county.

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### 2013-2014 Corporate Revenues and Profit Margins

<table>
<thead>
<tr>
<th></th>
<th>2013 Revenue ($M)</th>
<th>2014 Revenue Estimate ($M)</th>
<th>Production in Williams County as a % of 2013 total</th>
<th>2013 Operating Income Margin</th>
<th>Leases (thousands of acres held in the Bakken)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continental Resources</td>
<td>3,455.2</td>
<td>1,388.9</td>
<td>40%</td>
<td>39%</td>
<td>1,200</td>
</tr>
<tr>
<td>Hess Bakken Investments</td>
<td>22,284.0</td>
<td>583.3</td>
<td>3%</td>
<td>12%</td>
<td>640</td>
</tr>
<tr>
<td>Oasis Petroleum North America</td>
<td>1,142.0</td>
<td>634.0</td>
<td>56%</td>
<td>44%</td>
<td>507</td>
</tr>
<tr>
<td>Statoil</td>
<td>102,100.0</td>
<td>684.5</td>
<td>1%</td>
<td>25%</td>
<td>330</td>
</tr>
<tr>
<td>Kodiak Oil &amp; Gas</td>
<td>904.6</td>
<td>915.9</td>
<td>101%</td>
<td>38%</td>
<td>no data</td>
</tr>
<tr>
<td>XTO Energy*</td>
<td>-</td>
<td>359.2</td>
<td>-</td>
<td>845</td>
<td></td>
</tr>
</tbody>
</table>

* ExxonMobil, the shareholder of XTO Energy does not separately report revenue for the XTO Energy.

### State Revenue

North Dakota levies two taxes on oil and natural gas. The oil extraction tax goes directly to the state government. The oil and natural gas gross production tax, meant to take the place of a local property tax, accrues to impacted cities and counties.

### Summary of North Dakota Oil and Gas Taxes, 2013

<table>
<thead>
<tr>
<th>Production Taxes</th>
<th>· $0.833 per MCF of gas (changes annually on July 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraction Taxes</td>
<td>· 5% of gross value of natural gas or oil</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extraction Taxes</th>
<th>· 6.5% of gross oil value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>· 4% of gross oil value if well qualifies for reduced rate</td>
</tr>
<tr>
<td></td>
<td>· 2% of gross oil value for qualifying wells in Bakken formation</td>
</tr>
</tbody>
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The past five years have seen the aggregate value of taxable sales and purchases in North Dakota more than double, averaging over 14% growth annually. Most of the increase is due to the mining and oil sector. Total tax collection amounts to $4.1 billion in 2012 to

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almost $5.3 billion in 2013, a 27.8% increase. While severance tax revenues in 2013 ($2.5 billion) made up for more than 40% of the total tax revenues, the largest increase in tax contribution since the start of the oil boom is in sales tax revenues. Sales tax revenue added up to almost $1.8 billion in 2013, an increase of 225% from $800 million in 2007.  

Individual and corporate income taxes grew 193% from $450 million in 2007 to $870 million in 2013. Among the component sales taxes in North Dakota, alcohol beverage sales tax has gone through a steady and prominent growth of 42% from 2007-13. Amusement sales tax went up by 16% from 2007-09, and then declined continuously from 2009-13 by almost 50%. The associated social phenomenon is discussed in the following sections.

Due to relatively lower increase in oil and gas tax revenues and recent proposals regarding further reductions, these social institutions are by no means the biggest beneficiary from the oil boom. The oil extraction tax is deposited into an oil extraction development fund. Of this fund 20% is used to invest in North Dakota water development bonds and the southwest pipeline series. The North Dakota Water Commission deals with issues such as flood control, dam repair and reconstructions, irrigation, water supply and other purposes, while the pipeline series manages the provision of drinking water to residents.  

The fund is allocated to additional water projects decided by the Commission, and any excess is allocated to the industrial commission for development, study and grants for energy conservation projects. In a 2013 report, the North Dakota Water Commission estimated a $515 million to fund priority projects to be implemented from 2013-15, which

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44 Statistics are available from United States Census Bureau: State Government Tax Collections.  
is 28% of the North Dakota extraction tax from 2011-13. An additional 20% of the extraction tax is devoted to the common schools fund and foundation aid stabilization fund, the latter of which is to be used in the event of a shortfall in foundation aid funding for schools. Of the remaining 60% of the extraction tax, 30% is allocated to the state general fund. The other 30% is allocated to the Legacy Fund, a fund created in 2009 and locked until June 30, 2017. The administrators of the Legacy Fund have raised concerns over the out-of-state investors trying to demand further reductions on oil and gas taxes and prevent money from flowing into the Legacy Fund. They are also concerned that the state is making investment under the guidance of out-of-state entities.

The gross production tax is distributed monthly to different cities, counties and towns in the producing areas. The Legacy Fund receives 30% of the production taxes. Up to $100 million of the production tax revenue is devoted to an oil and gas impact grant fund, from which local governments can apply for funding of infrastructure. In 2013, for instance, the city of Williston requested $25 million for a sewer plant upgrade. It received $2 million.

\[ \text{County Revenue} \]

\[ \text{\textit{\footnotesize \cite{46}}} \]

\[ \text{\textit{\footnotesize \cite{47}}} \]

\[ \text{\textit{\footnotesize \cite{48}}} \]

\[ \text{\textit{\footnotesize \cite{49}}} \]
While fracking has led to huge increases in the state’s revenues, the distribution of that revenue has caused tensions in the counties, such as Williams County, that are heavily impacted from the boom. There is typically a revenue gap, between 2 to 5 years, between which the local municipality needs to provide infrastructure and public services to the booming population, but has yet to receive access to revenue generated in the boom. The distribution of tax revenue favors the state. The disparity is even more visible when compared with neighboring states: Montana, Colorado, and Wyoming. While municipalities in Colorado saw 63%, Montana 39%, and Wyoming 35%, the 19 North Dakota counties most affected by the Bakken boom received only 11.2% of state revenue from O&G ventures in fiscal 2012-13.\(^{50}\) Although, low occurrences of decentralization of oil and gas regulation to local governments by the State in North Dakota further discussed in the section on regulation and politics below can account for a portion of this difference.

![Fig 1: State vs. Local Share of Oil and Natural Gas Tax and Royalty Revenue](image)

**Fig 1: State vs. Local Share of Oil and Natural Gas Tax and Royalty Revenue**

*Source: Energy Fiscal Best Practices. Headwater Economics*

Despite the fact that Williston ranks the first among all North Dakota cities in sales tax contribution in the state, local tax revenues are not enough to cover the expenses of

\(^{50}\) *Energy Fiscal Best Practices. Headwater Economics.*
expanding infrastructure and services for the booming population.\textsuperscript{51} The city of Williston, for example, has an official population around 20,000 but is estimated to serve 38,000 individuals. With the rising social issues as one of the main concerns for the city administrators, Williston recently added a 1% city sales tax on top of the 5% state sales tax through 2020. This additional revenue is dedicated to infrastructure and property tax relief. Of the revenue, 25% is dedicated to community development projects such as workforce development designed to expand recruitment, community enhancement and improve life quality.\textsuperscript{52} By the start of the next decade, Williams County’s population is expected to grow 8%.\textsuperscript{53} New infrastructure necessary to keep up with the influx of Bakken oil workers could cost upwards of $625 million, with improvements needed on the airport, roads, water supplies, and other basic facilities. For example, if the city’s wastewater treatment facility reaches capacity before the estimated $100 million upgrade can occur, the city might be forced to halt building permits and restrict further development.

To cope with the influx in the population, the local budgets have increased to accommodate new infrastructure projects. In September 2014, Williston approved a $250 million budget\textsuperscript{54}, which is a five-fold increase of its budget four years ago. Roads account for $86 million of the 2015 allocations. Another $48 million is appropriated for sewer and water. The number of full-time city employees more than doubled between 2010 and 2014, from 108 to 226. Nearly $46.5 million of the proposed budget will go toward chipping away

\begin{footnotesize}
\begin{itemize}
  \item[\textsuperscript{52}] Ibid.
  \item[\textsuperscript{53}] Eberhart, Dan. CEO of Canary, LLC: \url{http://canaryusa.com/north-dakota-shale/}
  \item[\textsuperscript{54}] Wood, Josh. \textit{ND Oil Boomtown of Williston Approves $250 Million Budget}. Bismarck Tribune. September 12, 2014.
\end{itemize}
\end{footnotesize}
at the city's $140 million debt, which was largely accrued due to infrastructure projects. Despite the cities current debts, it is considering a $95 million loan from the Bank of North Dakota to bankroll the projects.

To combat the financial strain created by the fracking boom, Williston is having public hearings\(^5\) in October 2014 to discuss the 1% public safety sales tax that is on the ballot for November. Taxable items include pipeline, sand used in fracturing, lumber, clothes and tools, for example, but not vehicles, motor homes, food and gasoline. This is not the first time that Williston has been faced with dealing with the pressures created by an oil boom. During the 1980s, in the bust from the earlier 'boom,' Williston was left with $25 million in debt from unfinished infrastructure projects and no tax base to pay it off.\(^6\)

**Social Impact**

The abundance of well-paying jobs requiring minimal previous education and experience has drastically changed the demographic profile of Williams County. Accompanying the increase in Williams County population, there has been increase in crime. Both violent crime and property crime continue increasing through 2012. This is especially meaningful when compared to the crime rates of North Dakota as shown in the following figures. This trend is present in population adjusted numbers as well.\(^7\)

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\(^6\) Holeywell, Ryan. *North Dakota’s Oil Boom is a Blessing and a Curse.* Governing the States and Localities. August 2011.

By 2014, driving under the influence (DUI) arrests had increased by 1400%.

Drug trafficking has increased so alarmingly that the White House’s Drug Policy director designated the county as a High Intensity Drug Trafficking Area, meaning that it qualifies

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for federal supply of funding and personnel to tackle drug trafficking.\textsuperscript{59} The number of sex offenders in Williams County has tripled. In 2010, there were 43 registered sex offenders in Williams County,\textsuperscript{60} by early 2012 that number had doubled to 86 and as of October 2014, there were 130. Of the current 130, only 25 have convictions in North Dakota, meaning that roughly 80\% of them came from out of state.\textsuperscript{61}

The increase in primarily young males has been a significant component in the shift. A three year survey from 2007-09 found a sex ratio of 96.6 males for every 100 females. In 2011-13, which found 14,237 males (a 45\% increase) yet 12,672 females (only a 25\% increase), leading to a sex ratio of 112.4 males for every 100 females. During this period the state’s sex ratio only changed from 101.3 to 103.5 males per 100 females. It is also important to note that this survey likely significantly underestimates the male population, since it focuses on permanent residents, and a large portion of oil and gas workers are transient workers. Of the new male residents, 34.5\% are between 20 and 39 years old as compared to North Dakota as a whole where they constitute 30.4\%.\textsuperscript{62}

These young, transient workers have largely disposable income to spend, which impacted the consumer market in Williams County. Gambling revenue has doubled and strippers have higher wages than anywhere else in the country.\textsuperscript{63} By late 2011 strippers

\begin{footnotesize}
\begin{itemize}
    \item [61] North Dakota’s Office of the Attorney General’s Sex Offender Web Site.
    \item [62] See Age Sex Demographics Williams County data that was compiled from the US Census Bureau.
\end{itemize}
\end{footnotesize}
were making between $2,000 and $3,000 a night (roughly comparable to how much a Las Vegas stripper makes in a week).  

**Environmental Impact**

There are two main potential environmental hazards that arise from fracking: oil wastewater spills and natural gas flaring.

**Oil Wastewater Spills**

Beginning in 2011, there have been roughly 1,073 wastewater spills in North Dakota, the majority of which have been in Williams County. Two thirds have seeped into drinking and groundwater sources. Although the spill is brine, this brine is often laced with carcinogenic materials and radioactive substances which has significant effect on land and aquatic sources. It is possible that these numbers are even higher due to unreported spills.

Current technologies for treating the flowback or wastewater produced by fracking include: direct disposal to surface ponds for evaporation, deep-well injection, wellhead treatment and hypothetically, centralized water management. Half of the wastewater produced in the Bakken field is disposed in surface ponds, and the EPA is considering tightening regulations regarding the designs and operations of these surface ponds to reduce environmental impact. Deep-well injection, outlawed by Pennsylvania, remains as a popular method used in North Dakota. This method involves hauling away wastewater by

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66 Ibid
68 Easton, Jeff. "Fracking Wastewater Management: Is Centralised Treatment the Way Forward?" *WaterWorld Magazine*.  

23
trucks, incurring further road damages and traffic problems. The cost of hauling away wastewater is $3-$7 per barrel of oil produced.\textsuperscript{69}

Some producers use wellhead wastewater treatment to reprocess the flowback water from the deep wells. Reprocessed wastewater is used for refracturing the same well or new wells. Recycling is a more desirable method, reducing further consumption of fresh drinking water, and avoiding environmental damage involved in discharging wastewater to surface ponds and underground injection. The shortcoming of this method is that it does not provide continuous treatment of wastewater, which needs potentially 20 years of reprocessing. Centralized wastewater treatment processes wastewater within a radius of 40 to 50 miles.\textsuperscript{70} Pipelines connect directly to the centralized facilities, which can potentially integrate with facilities redirecting recycled water back to fracking sites. This would be a better method to process wastewater in the long run, but would require better funding for relevant infrastructure to be put in place.

Williston, ND drinking water quality has also remained unaffected, as consistent CCR water quality reports have shown results within EPA range.\textsuperscript{71} This could possibly be due to strategic sourcing of Williston (and other Williams County area) drinking water. It is brought into the city from the Missouri River, rather than from local watersheds that are at risk of being affected by wastewater runoff. It must be noted that according to source water assessment, the Missouri River is classified as being moderately susceptible to potential contaminants.\textsuperscript{72} It is unclear if this susceptibility is strictly due to fracking-induced causes,

\textsuperscript{69} Ibid
\textsuperscript{70} Ibid
\textsuperscript{71} City of Williston Water Department, \textit{Annual Drinking Water Quality Reports for the year of 2013}, Williston Government Printing Office, 2013
\textsuperscript{72} Ibid
but the water quality has remained consistently adherent to federal limits since 2010. Fracking also has taken roughly 12 billion litres freshwater out of circulation in North Dakota itself (as it converts fresh water into un-reusable toxic water). It is also important to account for potential environmental impact in Williams County due to certain current changes in the fracking trends. There is an increase in pad drilling in Williams County, which has been associated with ecosystem degradation and an increased threat to surface waters. Due to increasing population, there may be other indirect environmental impacts that arise from overcrowding and overpopulation, such as strain on natural resources and infrastructural impact to the area.

**Gas Flaring**

Gas flaring is the burning of any excess gas produced during the fracking process. In ND, 35% of gas found is flared, and in Williams County, (using Trenton 1-0718H Well as an example), 68,337 Mcf of gas has been flared in the years 2011-2013 of the well’s operation, giving it a ratio of 0.48 Mcf of gas flared per barrel of oil. Adjusting for number of wells in William’s County, we can say that 37.3 Million Mcf of gas is flared in William’s county since in the top three fields. A third of the flared gas in ND is a direct result of lack of infrastructure and overall difficulty in connecting the well to a natural gas pipeline. Gas

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73 Ibid
78 Complaint and demand for Jury Trial, State of North Dakota, County of Williams, Northwest Judicial District, August 2014
flaring poses an environmental risk, as the gas being flared releases a variety of greenhouse gases into the air, almost equivalent to the GHG emission of one million cars. It has also been attributed to the production of soot. The state of North Dakota, however, has taken steps to reduce GHG emission, through policy changes (venting is not permitted in North Dakota) as well as aiming to bring emissions down to 24% of gas found. North Dakota as a whole has already produced over 6.5 million metric tons of Global Warming pollution as GHG.

![Disposition of North Dakota natural gas production (Jan 2010 - August 2014)](https://example.com/disposition-chart.png)

**Fig. 4**

Source: U.S. Energy Information Administration based on North Dakota Industrial Commission

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80 Ibid


83 Ibid

84 Ibid

85 Ibid
Despite the prevalence of flaring, air quality in the North Dakota area is qualified as “Good” on the AQI Index, with a rating of 19, and no past rating going above 50. According to the North Dakota Air Quality Reports from 2010-13, Williston has not exceeded any of the 24 hour federal standards in all monitored gases and particulates. Williams County, however, still has over 9,000 individuals who are at risk of air quality induced health issues, as of 2014, possibly affected by the soot produced by gas flaring.

**Politics of Fracking and Regulatory Change**

The interest in decreasing U.S. dependence on foreign oil imports has led to increasing demands for domestic drilling oil. Internal opposition to further tapping oil and gas resources has led to ecologically protected regions like the Arctic National Wildlife Refuge in Alaska. The regulation of hydraulic fracturing was allocated to individual state legislatures. Fracking is currently exempt from principal federal environmental laws, specifically the Safe Drinking Water Act (SDWA) and its injection control program, unless the driller utilizes diesel fuel in the release process, making fracking regulation a state function. The EPA, however, is considering amending the SDWA and thereby enabling greater federal regulation of fracking. This was not received well by North Dakota representatives who worried about losing oil and gas income. In November 2011, North

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87 https://www.ndhealth.gov/aq/AmbientMonitoring.htm
89 Layzer, Judith. "Oil v. Wilderness in the Arctic Wildlife Refuge." The Environmental Case. 121. Print.
Dakota Governor Dalrymple signed off on a Bill setting aside $1 billion specifically to file a lawsuit against the EPA in the event that the agency would prevent oil production through hydraulic fracturing in the region. Increased federal involvement will lead to national uniformity, however, as evidenced by flaring regulations.

**State and Municipal Regulatory Bodies**

North Dakota’s state administrative code, as well as city ordinances within Williams County show that oil and gas production laws and regulation of related processes is controlled by the state.90 Williams County is overseen by a County Commission of five members91 and along with Williston city government, the administration oversees local regulate road use, implementation of state laws, and the oil and gas production insurance, bonding and fencing of well sites and pits.92 The North Dakota Industrial Commission (NDIC)93 serves as an umbrella organization to the Department of Mineral Resources (DMR),94 the Oil and Gas Division and the State Geological Survey. The North Dakota Petroleum Council (NDPC) serves as a liaison between the government and the more than 500 companies that is represents involved in all aspects of the oil and gas industry, including production, refining, pipeline, mineral leasing, consulting, legal work, and oil field maintenance throughout North Dakota.95

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90 See Williston City Ordinance: Chapter 2, Administration, Clerkbase
91 See N.D. Admin Code Chapter 11-11.
92 Hannah Wiseman, Francis Gradijan, ‘Regulation of Shale Gas Development, Including Hydraulic Fracturing’, University of Texas School of Law, (January 20, 2012)
94 Ibid.
Citizens of the area, however, view most of the above mentioned organizations are simply serving as lobbyists for drillers continuing to invest billions of dollars in the state. The NDPC states on its website that it is indeed dedicated to the improvement of the image and presence of oil and gas producers. In the 2012 gubernatorial election won by Mr. Dalrymple, substantial campaign contributions by Political Action Committees of Exxon Mobil Corporation, Continental, Marathon Oil and ConocoPhillips were revealed, all firms that stood to benefit greatly from a lack of hurdles to further construction of drilling mega units. Landowners and ranchers have been targeted by drillers’ claims to North Dakota’s eminent domain laws and the state’s ‘split estate’ property rights system, wherein mineral rights owners hold precedence over surface landowners. This is deeply contentious since drilling companies need only gain consent of 51% of mineral rights owners to begin operations. Farmers still pay taxes on land that is drilled and made unusable without their consent. This is partly offset by the $45 per acre compensation per year for land loss.

Changes in the Regulatory Landscape

For North Dakota, compared to other immensely energy rich states including Pennsylvania, Texas, and New York, regulation in the face of the 2007 boom remained unchanged and garnered relatively lower public attention. This can be attributed simply

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97 Ibid.
100 Ibid.
to the immense benefits incurred after the expansion influencing state regulators to encourage more and more investment.

Well after the boom took place, state regulators were forced to pay heed to these issues brought to the forefront by environmental protection organizations as well as public suits. In November 2011, Governor Dalrymple announced the allocation of $800 million to transportation, water and housing assistance to drilling impacted counties.\(^\text{102}\) Similarly, during the 2013 State Legislative Session, Governor Dalrymple approved a bill allocating another $1 billion collected in oil and gas tax to affected counties.\(^\text{103}\) To address contention between mineral rights and surface land owners, a written contract between mineral and surface owners must be negotiated for payment of surface damages caused during drilling as of August 2013.

In response to repeated instances explosions near fracking sites and high oil worker mortality concerns (North Dakota’s worker mortality rate is 654% greater than the national mortality), the state Administrative Code underwent revisions, for the first time since 2004, in January 2012. Operators must now disclose anticipated hydrogen sulfide content in the gas produced and the weight and grade of all casing material, giving the DMR right to deny applications based on potential of casing to become subject to sulfide stress and cracking as a result. To a similar end, the Site Construction Regulations\(^\text{105}\) now states

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\(^{105}\) See N.D. Admin Code 43-02-03-19
that any kind of soil stabilizing additives used at the site of construction must be approved by the DMR Director before the application is made. The guideline usage of reserve pits (for the storage of all fracking fluid waste, as well as solid drill cuttings) has been eliminated, pointing all fluid waste disposal concerns to the Underground Injection Control Chapter.\textsuperscript{106}

To address waste water spills and subsequent contamination of water supplied to homes, in April 2012, the state began to require all operators to transport fracking wastewater to underground disposal or injection wells, which if newly constructed, had to be located at least 500 ft. from any area of dwelling.\textsuperscript{107} The storage of waste water in open or even appropriately lined pits has led to several leaks especially when it rain resulting in significant damage of local flora. Out of a total 3,300 spills in the state, only 45 citations were issued by state regulators. The 2012 amendment also largely expanded investigative powers of the DMR in the event violations of conservation statutes. The code now includes the requirement of progress reports within 30 days of the beginning of a geophysical exploration project carried out by a new/potential operator.

The rapid changes to pre-boom policy helmed by the NDIC and their increased concentration over 2012-14 can be indicative of the wariness of state regulators of federal control as the senate continues to stress that federal regulations remain unnecessary and will interfere with current state and municipal law.\textsuperscript{108}

\textbf{Production Outlook}

\textsuperscript{106} See N.D. Admin Code 43-02-05
\textsuperscript{107} Ibid.
\textsuperscript{108} Ibid.
Approximately 1.1 billion barrels of oil have been recovered from the Bakken so far.\textsuperscript{109} Based on various estimates of reserves and production rates, fracking could continue in Williams County for 8 to 143 years\textsuperscript{110} (assuming constant production rates). The range is not very surprising because oil reserves estimates range from 7.3 billion barrels to 413 billion barrels. The U.S. Energy Information Administration (EIA) predicts that shale oil output will rise 37\% from about 3.5 million bpd in 2013 to 4.79 million barrels per day by 2020. The forecast includes the Bakken, Three Forks and Sanish, Eagle Ford, Woodford, Austin Chalk, Spraberry, Niobrara, Avalon/Bone Springs and Monterey. IHS Energy’s projections are higher, with an estimated 6 million bpd from the Bakken, Eagle Ford and sections of the Permian and Niobrara by the end of 2020. At the low end, Energy Aspects Ltd sees production of 3.5 million barrels a day from shale by 2017, a 1.5-million bpd increase from its current output estimate of 2 million bpd. McKinsey & Co.’s forecasts a range from 5 to 9 million bpd with oil production at the equivalent of 7.1 million bpd by 2020. BP estimated that U.S. tight oil production will increase to 4.5 million bpd in 2035. Exxon Mobil Corp. says global tight oil production, driven by North America, will rise 11-fold from 2010-40, when it will account for five percent of global liquids output.\textsuperscript{111} If current trends in rapid oil production rates continue, however, the overall production from the Bakken formations will be far less than predicted. This poses significant implications for the long-term economic and social impact on Williams County and North Dakota.


\textsuperscript{110} Based off estimates from the EIA, Exxon Mobil Corp, IHS Energy, Energy Aspects Ltd, and McKinsey

That said, production forecasts are inherently problematic, as they fail to anticipate major new discoveries or abrupt depletion rates. Taking into account the typical decline in oil well production over time (by the fifth year of operation the average well produces 33% of original production), the most conservative estimate of production forecasts concluded that the Bakken Shale oil production could peak in 2015. As long as oil prices are high, drilling will likely continue, but the benefits to the energy supply deteriorate while collateral damage to climate (in the form of total carbon dioxide emissions in the region) goes up.\textsuperscript{112}

\textbf{Fig 5: 2000-25 Oil Production for Bakken Shale vs. Number of Producing Wells}

The most pessimistic case, represented in figure 5, for the Bakken predicted peak production to be hit in 2015-17.\textsuperscript{113} This is based off Mountrail County, ND peak production

\textsuperscript{112} Pierrehumbert, Raymond. \textit{The Myth of “Saudi America”}. Slate. February 6, 2013.

\textsuperscript{113} E. Waggoner, C. Hall. \textit{Is the Bakken Formation the Answer to our Energy Independence?} American Geophysical Union, Fall Meeting 2012, abstract #GC23C-1089
which is believed to have been hit in March to April 2012. Since then the decline is especially apparent in the Mountrail County’s two largest producing fields, which suggests that much of production occurs in concentrated areas with high profitability, but rapid production declines overall. To maintain a consistent level of production and offset the declines, an increasing number of wells must be drilled throughout the lifetime of a field. Preliminary Energy Return on Investment (EROI) analysis, the ratio of energy outputs over energy inputs, indicates that newly developed fields in the Bakken are less profitable and yield far less energy than the larger producing predecessors.\(^{114}\)

**Price Sensitivity**

Fracking, as well as virtually all other oil and gas operations, is very sensitive to oil and gas prices. The price of oil has increased 322% between 2000 and 2013, while gas prices essentially remained at the same level, though it fluctuated significantly during that time period. The increase in oil prices caused a shift in the focus of fracking operations from the production of shale gas to oil. While this has generated higher revenues, fracking for oil requires more chemicals and is potentially more dangerous from an environmental standpoint. Price fluctuations cause significant variability in the breakeven points for each well/operation. In the core of the drilling area in the Bakken, the breakeven prices drop below $55/BBI, however, in the more fringe areas the cost can exceed $100/BBI. This is due largely to the infrastructure features surrounding the drill site and variations in the formation depth and completion technique.\(^{115}\) Despite these fluctuations, even the most

\(^{114}\) Ibid.

conservative estimates of recoverable oil in Williston County coupled with the EIA lowest oil price forecast through 2040 will likely keep oil companies interested in the area.

**Discussion of the Cost-Benefit Analysis**

**Overview**

Since we focus on the cost-benefit analysis of fracking in Williams County we are including only those benefits in costs that are ultimately absorbed by Williams County.

On the benefits side we include the following items into our analysis:

1. Portion of North Dakota severance taxes distributed to Williams County,
2. Increase in the value of real estate assets in Williams County,
3. Residence adjusted earnings of workers,
4. Employer contributions to pension & social insurance.

On the costs side we include the following items into our analysis:

1. Total costs of crime (social cost, cost of enforcement, rehabilitation, etc.),
2. Social cost of carbon emissions,
3. Costs of water used in fracking.

There is a number of costs and benefits that are unquantifiable and are not included in our study:

1. Certain health care costs,
2. Certain infrastructure costs,
3. Certain costs related to the risk of water pollution,
4. Benefits in the form in increased revenues of local retail, services, and other businesses.
Oil Reserves and Production Forecast

The following steps were taken in order to estimate what part of the Bakken oil reserves could be extracted in Williams County:

1. We took an EIA 2013 estimate of North Dakota’s total oil reserves and compared it with the lowest estimate of total Bakken reserves (USGS 2013), arriving at a ratio of 77%. We believe this to be the most conservative assumption.

2. We calculated monthly oil production in Williams County between January 2007 and August 2014 as a percentage of North Dakota’s total oil production in those months. We got a range of 6.3% to 18.1%. The average and median for the whole period are 11.65% and 10.64% respectively. The average and median since January 2012 are 15.2% and 15.7% respectively, which reflects significant growth in fracking for oil in Williams County in 2012 relative to other ND counties. Given that trend, and that North Dakota’s Industrial Commission estimates Williams County to have the second largest reserves in North Dakota after McKenzie County, we believe that 11% is a very conservative assumption for Williams County oil production as a % of ND total.

3. Using the ratio of 77% to arrive at North Dakota portion of total Bakken reserves, and the ratio of 11% to arrive at Williams County portion of North Dakota’s Bakken reserves, we obtained a range of total oil reserves in Williams County between 625 million barrels and 34 billion barrels, based on various total bakken reserves
estimates. All quoted studies estimated total *recoverable* reserves, therefore we used these number further in our calculation.

We also used another method to obtain a range of estimates for the oil reserves in Williams County. We took the North Dakota Industrial Commission estimate of total proven (not recoverable) reserves in Williams County of 28.9 billion barrels and applied a range of estimates for the recoverable reserves from a number of sources. The most conservative common estimate of recoverable reserves as a portion of proven reserves is 3%, the highest is 50% (from Price’s unpublished paper). We used the three conservatives ratios of 3%, 10%, and 18% to arrive a range of numbers for the recoverable oil reserves in Williams County.

We combined the results obtained using the above two methods and ranked them from lowest to highest. We selected 6 lowest estimates for our further calculation of production forecast.

In order to forecast production we used two possible production volumes. The first was the latest available Williams County production volume as of August 2014. The second was obtained by taking the North Dakota Industrial Commission estimate of total production volume in North Dakota in 2020, calculating the rate of increase that they are projecting for North Dakota total compared with current total production, and applying that rate to the current production volume in William County.

Using these two production rates we obtained a range of values of years that would be required to extract all of the oil in Williams County for each of our 6 reserves estimates. We obtained a range between 8 and 144 years.
In the range between 8 and 144 years we selected cases that resulted in a time period covered by the EIA oil price forecast to 2040, thus in our further calculation we focused on cases in the range between 8 and 26 years. We titled these cases from “Case 1” to “Case 5”.

Using the EIA forecast of oil prices to 2040 we calculated the total value of oil produced in each year for each of the cases at three EIA prices: low price, high price, and reference case. We calculated the net present value (NPV) for each production case and each price case. In our NPV calculation we used a range of discount rates from 5% to 20% and obtained a range between $23 billion and $108 billion for the NPV of oil produced in Williams County. These NPV values, however, are not included into the benefits of our cost-benefit analysis, because the vast majority of them is exported out of the county. However, these numbers are used to obtain estimates of taxes that can be collected on those revenues and distributed to Williams County.

In our severance tax collections estimate we are using the current North Dakota severance tax rate of 11.5%. Of these proceeds, 11% are currently being distributed to Williams County.

**Economic Benefits**

North Dakota has been showing a constant and high economic growth since 2009. It has a decreasing and low unemployment, especially within Williams County that has an unemployment rate of 1.8%. Our analysis includes includes the quantification of the unemployment by measuring the amount of money given to out-of-work individuals under unemployment insurance. This number has been constantly decreasing as well.
Furthermore, Williams County has seen a very dramatic increase in average weekly wage and personal income. Williams County was the biggest contributor to the North Dakota sales tax, and real estate values have also been remarkably increasing.

**Costs**

**Environmental Costs**

Our analysis of the environmental impact contains an estimate of the social cost of carbon by flaring unmarketable gas and a crude estimate of fresh water usage. Projection of future water usage in production is based on historical data and trends using ordinary least squares regression. The cost of water usage is calculated by multiplying total wells in Williams County with the average amount of water used per well for fracking purposes. This number is then multiplied by 2014 price of drinking water in Williams County. We have not calculated the costs of wastewater treatment for the following reasons: assuming that companies do not exit the area in large numbers by 2030, wastewater treatment will remain to be the responsibility of private companies. Moreover, we consider that recycled water is not suitable for human and agricultural consumption. Currently, the prevalent methods in North Dakota to deal with wastewater include: depositing it in surface ponds for evaporation and hauling it away for deep-well injections. Wastewater deposited through these two methods does not go back to freshwater cycle. Recycled wastewater at the wellheads is removed of most suspended solids, acid producing bacteria and other toxic substance. This treatment, however, does not remove most of the halides, a heavy metal
salt that can be harmful to humans and agricultural products.\textsuperscript{116} In Pennsylvania and Arkansas, for example, researchers have found that reprocessed wastewater discharged into surface water contains not only halides but also ozone and chlorine from the recycling process itself, both of which can form toxic byproducts.\textsuperscript{117}

In fact, through 2014 North Dakota has not yet widely adopted recycling technologies to reuse fracking fluids, not to mention to completely remove the toxicants to meet EPA’s drinking water standards. The “H2O Forward” recycling technology to reuse fracking fluids is only “gradually making its way to Bakken.”\textsuperscript{118} The goal is to recycle produced and flowback water to be used in the next well. Complete removal of toxicants is currently unrealistic considering its costs and industry’s lack of incentives.

Through 2014 the total amount of wastewater that can be injected in deep wells is not clear. The head of the Oil and Gas Division’s underground injection program, Mark Bohrer, says that 30 million barrels of wastewater from around the state have been injected into 400 wells in their life time.\textsuperscript{119} Fracking fluids are highly slick and can permeate microfissures in the rock formations.\textsuperscript{120} With 30 million barrels of wastewater trapped underneath North Dakota, it’s difficult to estimate the risks of underground leaks

\textsuperscript{117} Ibid.
\textsuperscript{119} Ibid.
of highly toxic wastewater which can reach drinking water sources. The long-term costs of this potential contamination are not calculated.

To calculate carbon emissions from gas flaring, we gathered data on total Mcf of gas flared in Williams County from 2007-2014. This was done by taking the available data on Mcf gas flared in North Dakota, and then taking 15% of that number to come to an estimate for gas flared in Williams County (as Williams County has 15% of the total oil wells in North Dakota.) This number was then converted to its equivalent in CO2 emitted (from the fact that 1 mole of CH4 produces 1 mole of CO2, comparing molar mass, and thus converting to metric tonnes.) This was then multiplied with the respective 5-year interval social costs of carbon emissions, as calculated by the Interagency Working Group on Social Cost of Carbon in May 2013. The estimate that was taken was from the revised estimates of the social costs of carbon, as calculated under a 3% discount rate was as follows:

<table>
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<tr>
<th>Year</th>
<th>5.0% Avg</th>
<th>3.0% Avg</th>
<th>2.5% Avg</th>
<th>3.0% 95th</th>
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<td>26</td>
<td>71</td>
<td>97</td>
<td>220</td>
</tr>
</tbody>
</table>

It was ideal to take the 3.0% discount rate in the calculation, as it is a reasonably conservative estimate of carbon costs. In case of carbon costs, it would not be feasible to include a lower social cost, as it can account for underestimated costs of emissions.
Costs of Crime

In determining the social costs for crime in Williams County as a result of fracking we have to divide the data into costs between 2007-2012 (the latest year the FBI has complete crime data) and 2013-2030 to account for projected future crime rates. To determine the costs of crime we are using crime reported to the the Williston police department as a proxy for Williams County. This was done both because the FBI does not keep countywide data and Williston contains approximately 70% of the population of Williams County\textsuperscript{121} and is the central hub of Williams County. To determine the monetary costs of crime we use the estimates from the National Institute of Public Health of the cost per incident of seven types of crime tracked by the FBI’s Uniform Crime Statistics service: murder/manslaughter, forcible rape, aggravated assault, burglary, larceny-theft and motor vehicle theft. The NIPH estimates include lifetime costs of each crime including, police department, legal, social and lifetime costs in 2007 dollars.

To determine the costs between 2007-2012 we need to project what the numbers of these seven types of crimes would have been without the fracking boom. To do this we averaged the amount of crime that occurred between 2000 and 2006. This was done because there appears to be no significant growth in either the amount of crime or the population during this period so it is reasonable to assume there would not be more growth past 2006 without the fracking boom. This average amount of each type of crime is used as the proxy for the amount of crime that would have occurred each year between 2007-2012 without fracking. The difference between this projected crime and the actual

\textsuperscript{121} United States Census Bureau. Annual Estimates of the Resident Population for Incorporated Places: April 1, 2010 to July 1, 2013
crime data is the amount of additional crime from 2008-2012 caused by the fracking boom. The amount of extra crime in each of the seven categories is then multiplied by the cost per incident for each category to determine the cost of each crime each year. These are all summed up to determine the total cost of crime from fracking for 2007-2012. Since this is in 2008 dollars this was then converted to 2012 dollars.

To determine the additional crime costs of fracking from 2012-2030 we needed two projections: one that estimates the amount of crime that would occur without fracking and one that estimates the amount of crime that would occur with fracking. To determine the without fracking scenario we used the same method of averaging the amount of crime occurring between 2000 and 2006 and this number was used as the level of crime for each year from 2013-2030. To project the amount of crime with fracking we used an ordinary least squares linear regression equation to project the amount of crime for the years 2013-2020 from the rate of growth in crime from 2007-2012. A linear regression was used because it closest fit most of the data and other growth rates led to outlandishly large amounts of crime. We use the assumption that crime levels will plateau at 2020 so the crime numbers for 2020 are mirrored for the next ten years through 2030. The difference between these two projections is the amount of crime caused by fracking. The amounts of each crime are multiplied by the NIPH social costs to determine the yearly cost of crime from fracking. The net present value of all of these future costs was determined with a seven percent discount rate to determine the total cost of crime from fracking from 2013-2030. Then this number was converted to 2012 dollars, added to the total cost of crime from fracking from 2007-2012 to arrive at the total cost of crime from fracking.
**Cost-Benefit Analysis Results**

When all of the benefits are added the total quantifiable benefits are $3,344,484,812. The total quantifiable costs are $2,773,296,447. This results in a net benefit of fracking in Williams County of $571,188,365.

**Weaknesses of Cost-Benefit Analysis and Unquantifiable Costs**

The cost-benefit analysis has its shortcomings. The oil boom has led a rapid transformation of Williams County's demographic and economic structure. Much of the short-term economic boom the County has witnessed so far may not last long as some oil enthusiasts assume. Part of the reason why rapid economic growth has incurred relatively lower social and environmental costs is that it takes time for these long-term effects to manifest. Lack of systematic studies with unambiguous data also adds to the difficulty of quantifying the externalities. Overtime, as more results of on-going researches become available, the evaluation of costs against benefits might look drastically different from the one we currently have.

**Infrastructure Costs**

Infrastructure costs are highly variable. As we have mentioned earlier, infrastructure development in Williams County has not caught up with the economic expansion. Most of the temporary workers live in settlements that are not equipped with running water or electricity. Housing facilities are not up-to-date and require upgrade or renovation. Public projects including airport construction, extension of pipeline network series, roads, medical institutions and public security offices are all in need of improvement. Building permits and restrictions associated with these projects further add
to the burden of the county. Apart from these social projects, infrastructure associated with environmental protection and wastewater treatment would also need generous funding. This would include pipeline networks to transfer wastewater to a centralized treatment facilities and the reprocessed fluid back, or to transfer excessive gas produced in the oil extraction process. For instance, the 80 mile Tioga Lateral Pipeline recently completed in North Dakota moves 126.4 million cubic feet of rich natural gas per day from Tioga to Sherwood. The pipeline cost $170 million. While there have been historical pipeline projects, it is hard to make projections due to lack of regularity of historical data.

**Health Costs**

Up to this point, there has been no comprehensive research on the damage of fracking to human health. The National Institute of Occupational Safety and Health warned that toxins in fracking fluid, wastewater, air polluted by trucks and equipments, might subject workers to a higher risk of silicosis. This lung disease cost $50 million in medical care expenses in the United States in 2007. The cost of silicosis is not included in our analysis because there has been no systematic study clarifying the statistics. Residents near fracking sites around the nation have reported a variety of symptoms, such as headaches, nose-bleeding and nausea. It is not yet clear what the causes of these symptoms are.

We were able to find data to estimate the costs of adult and pediatric asthma and chronic obstructive pulmonary disease (COPD) in Williams County in 2014. Both diseases

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are associated with air pollution caused by increasing fracking activities. The American Lung Association, in their State of the Air Report, estimates in 2014 that the number of children at the risk of getting asthma in Williams County is 408, and this number is 1547 for adults. The number of Williams County residents at the risk of getting COPD is 793.\textsuperscript{124} A study published in Journal of Allergy and Clinical Immunology from 2002 estimates that the total per-person annual costs of asthma averaged $4912, with direct and indirect costs accounting for $3180 (65%) and $1732 (35%).\textsuperscript{125} Direct costs are associated with pharmaceutical, hospital admissions and non–emergency department ambulatory visits, while indirect costs take into account cessation and disruption of work. However, there is no existing study revealing the trends in number of people exposed to these risks in Williams County, hence it will be difficult to estimate long term costs of health issues.

**Public Opinion**

Surveys of residents from northwestern North Dakota show that around 68% of residents believe there are “too many newcomers.” They are of the opinion that the inflow of workers has put a strain on city services; the majority of residents (82%) disagree or strongly disagree with the claim that the city services can handle such increase in population. An overwhelming 97% agree (79% strongly) believe that the highways are becoming less safe. The majority (78%) think drugs and alcohol are becoming more serious problems. The vast majority (93%) strongly agree that the oil boom has


economically affected the county. When asked if their lives had improved, 52% disagreed, 30% were neutral, and 17% agreed. Roughly 58% of respondents agreed that the oil boom has been good for their community and 53% agree it has been good for their own family.\textsuperscript{126} The sentiment among residents is largely that these changes were long overdue. On the whole, residents acknowledge fracking as the future of production in the state.\textsuperscript{127}

\textsuperscript{126} \url{http://arts-sciences.und.edu/geography/files/docs/oil_boom_survey_results.pdf}  
Fig. 6 (a) and (b): Results of Citizen Surveys

"My Quality of Life has Improved"

- No Response: 25.3%
- Strongly Agree: 11.8%
- Agree: 27%
- Neutral: 30%
- Disagree: 19.4%
- Strongly Disagree: 44.7%

"Drugs and Alcohol are Becoming more Serious Problems"

- No Response: 32.6%
- Strongly Agree: 44.7%
- Agree: 19.4%
- Neutral: 27%
- Disagree: 11.8%
- Strongly Disagree: 25.3%
Conclusions and Policy Recommendations

Our overview of economic, social, political and environmental impacts of fracking in Williams County highlights the difficulties connected with an overall assessment of the practice. At a glance, the economic benefits are very high, as are social and environmental costs. Economic benefits are difficult to quantify because different geologic studies have varying and sometimes conflicting results of the estimates of oil reserves in the Bakken shale formation. In addition to production volumes, oil prices vary. Oil prices are likely the most volatile variable in the equation, but at the same time they greatly impact fracking rates because at low prices wells have the potential to become unprofitable.

In terms of costs in the analysis, several are difficult to quantify. This is partly due to the inavailability of reliable data to make estimates. For example, due to the high density of pipeline expansion and construction projects being undertaken yearly at different scales by a variety of energy firms, transportation and infrastructure costs were unquantifiable. These challenges are reflected in the political aspects of fracking. Regulations tend to be pro-fracking in counties and states where oil companies dominate political campaign contributions, while environmental studies are lacking about the long-term effects of fracking. With these considerations in mind, we discuss inferences made from our cost-benefit analysis below.

We found that costs are largely local, while economic benefits extend regionally or nationally (i.e. distributed to the state or outside of the state.) Costs incurred from environmental contamination, such as air and water pollution, soil erosion and pollution of the land, and exhaustion of arable water resources are local or have the highest impact at
the county level. The impact on local community, such as crime as well as infrastructural investments, again pertain to the local level and are monitored by county and city authorities. Simultaneously, companies extracting oil and gas from wells in Williams County are national operators, who export not only their products, but also the large profits made from fracking. The current taxation system leaves only a small portion of corporate revenues in the state, and a much smaller share of that revenue is made available to Williams County annually.

While most costs are local, the local authorities typically do not have the power to oppose fracking. The oil and gas industry of North Dakota is largely regulated by the NDIC with very little decentralization to county governments. The State Administrative Code covers all environmental protection laws as well as taxation policy. The Department of the Interior is also holding discussions with states where widespread fracking activity occurs with the aim to amend federal regulations to control fracking. Therefore, state and federal policymakers must take into account the interests and grievances of local communities that are impacted by fracking laws made at the center. In the long term, the transfer of greater power to local councils and commissions for fracking regulation as in states like Montana, Colorado and Wyoming could be an effective way to address landowner and other citizen concerns with greater efficacy.

Furthermore, care must be exercised in conducting, interpreting and using cost-benefit analysis to assess the practice of fracking. The challenges of cost-benefit analyses of fracking include availability of data, accuracy of estimates of oil reserves, volatility of oil prices and risks of regulatory changes, among others. Perhaps the biggest
challenge lies in measuring and quantifying environmental costs and showing causal relationships between fracking and observed environmental and health impacts. One possible solution to this challenge is for local authorities to conduct their own environmental impact studies, particularly in regions of close proximity to drilling units. Their individual findings can then be used to inform surveys with larger scopes. Specifically to address the causal challenge, state authorities should conduct more frequent analyses of the chemical disclosure reports made by operators and insist on greater transparency in materials used, some of which are now protected as Industry Secrets. Additionally, conducting periodic checks using harmless additives as markers to trace the path of usual components and fracking wastes to determine the extent of contamination, could be mandated.

Social costs of fracking in Williams County are lower because it is less densely populated areas than other fracking states. In pursuit of greater investments, state authorities are likely to remain biased against the mitigation social costs of increased crime and changing demographics in Williams County, while production and economic growth for the state is possible. Given that certain parts of the country, both states (e.g. New York) and counties (e.g. Mora County, NM) have been able to lay bans on fracking, the lack of will of regulators currently in power in the state can be seen as a major determinant of further hydraulic fracturing prevalence and rates in the county and the resulting increase of social costs.

Environmental costs are likely to remain high, because we accounted for social costs associated with carbon emissions, as well as the opportunity cost of the water used in the
fracking process. The social costs of carbon are corroborated with those estimated by the Interagency Working Group on Social Cost of Carbon of the United States Government. Considering the demographics and small population of Williams County, the high cost of carbon emission are even more stark. Furthermore, the cost of removal of water from the carbon cycle is monetized by considering the potential use-value of this water, which is in this case its utilization in the drinking water cycle of the Williston basin region. With the costs of water in Williston being $2.6/100 cubic feet until 3,000 cubic feet, and $2.25/100 cubic feet after 3,000 cubic feet, the estimates for the amount of water lost to fracking are still very high.

Consequently, environmental costs coupled with transportation challenges discussed earlier in the paper impact the agricultural industry the most. This suggests that there might be a tradeoff between fracking and agriculture: the more fracking is done, the higher is the negative impact on agriculture. One policy measure that could be suggested based on this conclusion is setting and maintaining a regulatory balance between energy and agriculture within specific county divisions. While farmers are compensated for damage made to their land on account of drilling, the dependence of lawmakers and landowners on this monetary relief should not allow large scale degradation of fertile soil. Amendments to the administrative code to include more stringent control of land quality should be considered in the future. Increasing focus on agricultural production will also relieve the impact of eventual depletion of shale reserves.
Although fracking appears to be a satisfactory short to medium term solution to US energy needs, it contributes to increased hydrocarbon emissions and according to many studies, global warming. There are many more efficient sources of energy that do not contribute as much to emissions. Finally, after taking into account the variability of social and environmental costs, at current oil prices, the economic benefits of fracking in Williams County clearly outweigh the costs. For these reasons, we believe that while fracking will likely continue to be an invaluable source of energy, corporations, state and federal authorities are advised to continue to work on determining the long term environmental impacts of hydraulic fracturing.
## Appendix

### Production of Top 20 Operators in Williams County, June 2014

<table>
<thead>
<tr>
<th>Operator Name</th>
<th>Oil Produced (BBLS)</th>
<th>Value of Oil Produced ($M)</th>
<th>Gas Produced (MCF)</th>
<th>Value of Gas Produced ($M)</th>
<th>Active Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continental Resources, Inc.</td>
<td>1,094,065</td>
<td>115.7</td>
<td>1,555,199</td>
<td>7.4</td>
<td>314</td>
</tr>
<tr>
<td>Hess Bakken Investments II, LLC</td>
<td>459,466</td>
<td>48.6</td>
<td>1,298,731</td>
<td>6.2</td>
<td>262</td>
</tr>
<tr>
<td>Oasis Petroleum North America LLC</td>
<td>499,404</td>
<td>52.8</td>
<td>436,965</td>
<td>2.1</td>
<td>165</td>
</tr>
<tr>
<td>Statoil Oil &amp; Gas LP</td>
<td>539,175</td>
<td>57.0</td>
<td>471,342</td>
<td>2.3</td>
<td>148</td>
</tr>
<tr>
<td>Kodiak Oil &amp; Gas (USA) Inc.</td>
<td>721,486</td>
<td>76.3</td>
<td>1,218,191</td>
<td>5.8</td>
<td>134</td>
</tr>
<tr>
<td>XTO Energy Inc.</td>
<td>282,961</td>
<td>29.9</td>
<td>453,168</td>
<td>2.2</td>
<td>126</td>
</tr>
<tr>
<td>HRC Operating, LLC</td>
<td>258,281</td>
<td>27.3</td>
<td>207,941</td>
<td>1.0</td>
<td>89</td>
</tr>
<tr>
<td>Murex Petroleum Corporation</td>
<td>57,182</td>
<td>6.0</td>
<td>96,157</td>
<td>0.5</td>
<td>49</td>
</tr>
<tr>
<td>Zavanna, LLC</td>
<td>114,312</td>
<td>12.1</td>
<td>130,893</td>
<td>0.6</td>
<td>39</td>
</tr>
<tr>
<td>EOG Resources, Inc.</td>
<td>72,312</td>
<td>7.6</td>
<td>66,490</td>
<td>0.3</td>
<td>37</td>
</tr>
<tr>
<td>Petro-Hunt, L.L.C.</td>
<td>129,568</td>
<td>13.7</td>
<td>164,127</td>
<td>0.8</td>
<td>22</td>
</tr>
<tr>
<td>Crescent Point Energy U.S. Corp.</td>
<td>35,671</td>
<td>3.8</td>
<td>44,856</td>
<td>0.2</td>
<td>20</td>
</tr>
<tr>
<td>Whiting Oil And Gas Corporation</td>
<td>52,899</td>
<td>5.6</td>
<td>80,744</td>
<td>0.4</td>
<td>17</td>
</tr>
<tr>
<td>Liberty Resources Management Company, LLC</td>
<td>68,026</td>
<td>7.2</td>
<td>183,889</td>
<td>0.9</td>
<td>12</td>
</tr>
<tr>
<td>Slawson Exploration Company, Inc.</td>
<td>87,699</td>
<td>9.3</td>
<td>38,174</td>
<td>0.2</td>
<td>12</td>
</tr>
<tr>
<td>Marathon Exploration Company, Inc.</td>
<td>12,037</td>
<td>1.3</td>
<td>23,198</td>
<td>0.1</td>
<td>9</td>
</tr>
<tr>
<td>Triangle USA Petroleum Corporation</td>
<td>31,583</td>
<td>3.3</td>
<td>18,699</td>
<td>0.09</td>
<td>8</td>
</tr>
<tr>
<td>Hunt Oil Company</td>
<td>14,887</td>
<td>1.6</td>
<td>13,673</td>
<td>0.07</td>
<td>6</td>
</tr>
<tr>
<td>SM Energy Company</td>
<td>15,034</td>
<td>1.6</td>
<td>12,699</td>
<td>0.06</td>
<td>6</td>
</tr>
<tr>
<td>Gadeco, LLC</td>
<td>10,116</td>
<td>1.1</td>
<td>10,139</td>
<td>0.05</td>
<td>2</td>
</tr>
</tbody>
</table>

| Total                                               | 4,556,164           | $482                       | 6,525,275          | $31                        | 1,477        |
| Top 20 Total                                        | 4,703,607           | 6,628,644                  | 1,655              | 89%                        | 89%          |
| Williams Cty Total                                  | 32,778,524          | $3,468                     | 37,594,631         | $180                      | 11,079       |
| Williams Cty as % of ND Total                       | 14%                 | 18%                        | 15%                |                            |              |

Notes: * North Dakota Department of Mineral Resources data  
Sources: [http://www.drillingedge.com](http://www.drillingedge.com), [https://www.dmr.nd.gov/oilgas/mpr/2014_06.pdf](https://www.dmr.nd.gov/oilgas/mpr/2014_06.pdf)
**Breakdown of Industry Employment Trends across North Dakota**

<table>
<thead>
<tr>
<th>SOUTH DAKOTA</th>
<th>Aug 2013</th>
<th>Jul 2013</th>
<th>M/M Numeric Change</th>
<th>M/M Percent Change</th>
<th>Aug 2012</th>
<th>Y/Y Numeric Change</th>
<th>Y/Y Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Employment</td>
<td>444,700</td>
<td>443,500</td>
<td>1,200</td>
<td>0.3%</td>
<td>430,900</td>
<td>13,800</td>
<td>3.2%</td>
</tr>
<tr>
<td>Mining &amp; Logging</td>
<td>32,000</td>
<td>30,700</td>
<td>1,300</td>
<td>4.2%</td>
<td>26,000</td>
<td>6,000</td>
<td>23.1%</td>
</tr>
<tr>
<td>Construction</td>
<td>35,900</td>
<td>36,000</td>
<td>-100</td>
<td>-0.3%</td>
<td>33,900</td>
<td>2,000</td>
<td>5.9%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>25,900</td>
<td>25,800</td>
<td>100</td>
<td>0.4%</td>
<td>26,000</td>
<td>-100</td>
<td>-0.4%</td>
</tr>
<tr>
<td>Wholesale Trade</td>
<td>25,800</td>
<td>26,500</td>
<td>-700</td>
<td>-2.6%</td>
<td>25,700</td>
<td>100</td>
<td>0.4%</td>
</tr>
<tr>
<td>Retail Trade</td>
<td>48,200</td>
<td>48,000</td>
<td>200</td>
<td>0.4%</td>
<td>47,100</td>
<td>1,100</td>
<td>2.3%</td>
</tr>
<tr>
<td>Transportation, Warehousing, &amp;</td>
<td>26,500</td>
<td>26,000</td>
<td>500</td>
<td>1.9%</td>
<td>25,300</td>
<td>1,200</td>
<td>4.7%</td>
</tr>
<tr>
<td>Utilities</td>
<td>6,900</td>
<td>6,900</td>
<td>0</td>
<td>0.0%</td>
<td>7,000</td>
<td>-100</td>
<td>-1.4%</td>
</tr>
<tr>
<td>Information</td>
<td>23,700</td>
<td>23,600</td>
<td>100</td>
<td>0.4%</td>
<td>22,000</td>
<td>1,700</td>
<td>7.7%</td>
</tr>
<tr>
<td>Financial Activities</td>
<td>35,800</td>
<td>35,800</td>
<td>0</td>
<td>0.0%</td>
<td>33,900</td>
<td>1,900</td>
<td>5.6%</td>
</tr>
<tr>
<td>Professional &amp; Business</td>
<td>58,200</td>
<td>58,700</td>
<td>-500</td>
<td>-0.9%</td>
<td>58,200</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Services</td>
<td>39,200</td>
<td>39,100</td>
<td>100</td>
<td>0.3%</td>
<td>39,400</td>
<td>-200</td>
<td>-0.5%</td>
</tr>
<tr>
<td>Education &amp; Health Services</td>
<td>15,700</td>
<td>15,200</td>
<td>500</td>
<td>3.3%</td>
<td>16,200</td>
<td>-500</td>
<td>-3.1%</td>
</tr>
<tr>
<td>Government</td>
<td>70,900</td>
<td>71,200</td>
<td>-300</td>
<td>-0.4%</td>
<td>70,200</td>
<td>700</td>
<td>1.0%</td>
</tr>
</tbody>
</table>