Appendix A: IMPLAN Model Analysis and Methodology

City of Minot, North Dakota

Appendix A: IMPLAN Model Analysis and Methodology

Study Approach

This section describes the economic modeling process, data requirements, model assumptions, and study multipliers used in this report to estimate the economic impacts of the petroleum industry in the Minot region.

The Economic Modeling Process

All economic impacts for the petroleum industry in the Minot region were calculated using an input-output model. The input-output model considers economic impacts associated with oil and gas drilling, extraction, and production; infrastructure development; professional services; transportation; and wholesale trade and manufacturing. Impacts that are discussed include the following:

- **Direct Impacts** – Direct impacts include the employment, payroll, and spending of two broad categories of firms involved in the petroleum industry: direct oil and gas establishments and related oil and gas establishments. Direct establishments are involved in all activities tied directly to well-pad operations, including the drilling, extraction, and production of crude oil, natural gas, or natural gas liquids. Related establishments are involved in key support activities for well-pad development, operation, and maintenance including infrastructure development, professional services, transportation, and wholesale trade and manufacturing.[80]
- **Multiplier Impacts** – Multiplier impacts consist of indirect and induced impacts. Indirect impacts are related to the recirculation of monies spent locally by direct and related oil and gas establishments. For example, when an oil exploration and production company purchases services and products from firms providing support activities to the petroleum industry, this expenditure circulates through the local economy. Induced impacts are the impacts resulting from the recirculation of employee payroll within the economy. For example, as employees in the petroleum industry spend their salary for housing, food, and services, those expenditures also circulate through the economy resulting in increased spending, payroll, and employment throughout the Minot region. As this money is spent

80 The term "well-pad" refers to the practice of pad drilling, an activity that involves drilling multiple wellbores from a single surface location. Pad drilling is a relatively new practice in the petroleum industry, with wide implementation beginning in 2006. Before pad drilling, oil and gas exploration and production firms would drill a single well at a site, disassemble the drilling rig, move it to a new location, and then drill another well. Pad drilling has saved firms time and money by enabling them to drill 5, 10, 20, or more wells from a single, compact piece of land rather than repeatedly moving the rig and preparing a new drilling site. This practice also reduces the impact on the environment. For more information, see: http://info.drillinginfo.com/launch-pad-rise-pad-drilling/.

several times, it eventually leaks beyond the boundaries of the study area, and thus no longer benefits the region's citizens. The economic model uses parameters specific to the Minot region to estimate the leakage effect associated with petroleum industry activities.

- **Total Impacts** – Total impacts are the sum of all direct and multiplier (indirect and induced) economic activities attributable to direct and related oil and gas establishments.

Note that because multiplier impacts are not as easily quantified as direct impacts, a reliable method for estimating multiplier impacts must be applied. As such, the Impact Analysis for Planning (IMPLAN) model was used to quantify multiplier (indirect and induced) impacts. IMPLAN is an input-output model that estimates purchases and sales between various sectors of the economy, and is one of the leading methods available for estimating the total economic impact of an industry (in this case, the petroleum industry).

The IMPLAN model contains a large economic database that is used to generate input-output tables. IMPLAN multipliers and input-output tables specific to the Minot region's industrial sectors were obtained and used in this analysis. The model used for this analysis requires estimates for three separate components of the economy. These categories include the following:

- **Employment** – Employment is based on the total of full-time jobs plus part-time jobs. In this analysis, two part-time positions are the equivalent of a single full-time position.
- **Payroll** – Payroll represents the annual salary, wages, and benefits paid to all employees.
- **Economic Output (Spending)** – Output includes expenditures by direct and related oil and gas establishments for petroleum industry activities. Examples include exploration, extraction, production, and transportation of crude oil, natural gas, and natural gas liquids and the provision of engineering, surveying, and consulting services for well-pad development, operation, and maintenance. For direct oil and gas establishments, output also includes various revenue streams originating from both oil and gas exploration, such as lease bonuses, or oil and gas production, such as severance taxes and royalty payments.

It is important to note that payroll and economic output cannot be directly combined because some elements related to payroll are also contained in the output estimate. Each of the three impact components (employment, payroll, and economic output) stands alone as a measure of the petroleum industry's total economic impact in the Minot region.

Data Requirements and Model Assumptions

Data related to petroleum industry activities in North Dakota was gathered for this analysis. This data served as inputs to the modeling process to identify total economic impacts. Data for the following categories of petroleum industry activities was required to estimate direct impacts:

- **Oil and Gas Drilling, Extraction, and Production** – Firms in this category are involved in the drilling, extraction, or production of crude oil, natural gas, or natural gas liquids. This includes services such as exploration (except geophysical surveying and mapping); excavating slush pits and cellars; well surveying; running, cutting, and pulling casings, tubes, and rods; cementing and shooting wells; perforating well casings; acidizing and chemically treating

wells; and cleaning out, bailing, and swabbing wells. All activities tied directly to well-pad operations are included in this category.[81]

- **Infrastructure Development** – This category includes establishments involved in providing necessary well-pad infrastructure including such activities as the development and construction of the well pad and surrounding site and any service roads to the well pad; pipeline development, use, and maintenance; power generation and distribution (e.g., power lines connecting the well pad to the power grid); gravel and scoria quarrying for service road construction; landfill operation (e.g., accepting of well-pad production waste); bulk petroleum storage; and supplying water for well-pad drilling and production. Excluded from this category are temporary and permanent residential housing construction, commercial or industrial construction not directly related to the well pad, and establishments involved in the supply or manufacture of well-pad materials.[82]
- **Professional Services** – Firms in this category provide services necessary for well-pad development, operation, and maintenance such as engineering services; consulting services; technical services; surveying; specialized repair services; testing laboratories; equipment leasing services; mineral rights services (landmen); and remediation services. Establishments engaged in administrative, management, scientific, and legal services specific to oil and gas development are also included in this category.[83]
- **Transportation** – These establishments transport supplies to the well pad in order to drill for oil and natural gas. This includes activities such as the transportation of oil, natural gas, production water, oilfield waste, and well-pad materials (e.g., supplies, chemicals, equipment, and machinery); transportation freight arrangement; hot shot services; and support activities for road and rail transportation including loading and unloading rail cars and operating independent terminals. Although establishments involved in support activities for rail transportation are included, railroad operators themselves are excluded. Establishments involved in the transportation of goods to retailers (gas stations, supermarkets, big box stores, etc.), the transportation of workers to and from worksites, and the transportation of agricultural products are also excluded.[84]
- **Wholesale Trade and Manufacturing** – Establishments in this category are involved in the supply or manufacture of materials that are unique, dedicated, and/or critical to well-pad construction, operation, or maintenance including materials such as electrical components; industrial equipment or machinery and related parts; storage tanks; concrete; proppants; and acids, chemicals, and other fluids. Excluded are firms whose wholesale supplies or manufactured items are not required for well-pad operations.[85]

[81] https://www.ndworkforceintelligence.com/admin/gsipub/htmlarea/uploads/lmi_ogempreport2015.pdf

[82] Ibid.

[83] Ibid.

[84] Ibid.

[85] Ibid.

Direct economic impacts presented in this report were estimated based on data obtained from Job Service North Dakota's Labor Market Information Center. In 2013, The North Dakota Legislature directed Job Service North Dakota (JSND) to quantify employment and wages attributable to the state's oil and gas industry. Subsequently, JSND has issued the North Dakota Oil and Gas Employment Report for 2013, 2014 and 2015. Each annual report provides a detailed view of North Dakota's petroleum industry at state, county, and city levels using data collected via a special survey and supplemented with data from established sources. This economic impact analysis uses data from JSND's 2015 North Dakota Oil and Gas Employment Report, released in June 2016.

In JSND's 2015 North Dakota Oil and Gas Employment Report, total petroleum industry employment in 2015 is provided by county. For some counties, including Bottineau, Mountrail, Renville, and Ward in the Minot region, employment data is also provided for each category of petroleum industry activity considered in this economic impact analysis (i.e., oil and gas drilling, extraction and production; infrastructure development; professional services; transportation; and wholesale trade and manufacturing). The employment figures for these categories served as direct employment impacts for 2015 for Bottineau, Mountrail, Renville, and Ward counties. For counties where JSND's employment figures were not broken out, estimates of employment within each category of petroleum industry activities were made by applying percentages of those counties' 2015 total employment within North American Industry Classification System (NAICS) codes that corresponded to each category to the counties' total petroleum industry employment.[86]

Once the direct employment impacts for 2015 were estimated, growth rates were applied to estimate direct employment through 2024. The growth rates used in this analysis were obtained from the North Dakota Department of Mineral Resources - Oil and Gas Division's projections of oil and gas drilling, fracking, gathering, and production jobs in the state through 2050. These projections were presented at the North Dakota Petroleum Council's annual meeting in September 2016.[87] This analysis assumed that jobs in infrastructure development, professional services, transportation, and warehousing and manufacturing would grow at the same rates as drilling, fracking, gathering, and production jobs.

The results of this methodology are presented in **Table A-1**. As shown in the table, direct employment in the petroleum industry in the Minot region is projected to increase from nearly 7,700 employees in 2015 to approximately 17,400 employees in 2024 at an AAGR of 9.5 percent, based on the North Dakota Department of Mineral Resources – Oil and Gas Division's projections.

The direct employment impacts in **Table A-1** served as inputs to the IMPLAN model, which estimated direct payroll and output impacts as well as subsequent multiplier impacts.

86 Total employment in 2015 within NAICS codes for each county was obtained from the corresponding Area Profile published by JSND, available at: https://www.ndworkforceintelligence.com/gsipub/index.asp?docid=350.

87 http://www.ndoil.org/image/cache/Rob_Lindberg.pdf, Page 23

Table A-1: Direct Employment Estimates of the Petroleum Industry Minot Region, 2015-2024

Petroleum Industry Category	2015	2016	2017	2018	2019	2024	AAGR 2015-2019	AAGR 2015-2024
Oil and Gas Drilling, Extraction, & Production	3,166	3,448	3,900	4,579	5,314	7,179	13.8%	9.5%
Infrastructure Development	1,152	1,254	1,419	1,666	1,933	2,612	13.8%	9.5%
Professional Services	745	811	917	1,077	1,250	1,689	13.8%	9.5%
Transportation	1,806	1,968	2,226	2,613	3,032	4,097	13.8%	9.5%
Wholesale Trade & Manufacturing	796	867	980	1,151	1,335	1,804	13.8%	9.5%
Total	**7,664**	**8,348**	**9,443**	**11,085**	**12,864**	**17,380**	13.8%	9.5%

Source: CDM Smith

Study Multipliers – Multiplier Impacts

Employment, payroll, and output impacts derived from firms engaged in the oil and gas drilling, extraction, and production; infrastructure development; professional services; transportation; and wholesale trade and manufacturing categories comprise direct economic impacts. As these impacts enter the economy, they circulate among other economic sectors, creating multiplier impacts of additional spending.

Multiplier impacts arise from various interdependencies within an economic system. For example, the operation of an oil and gas extraction firm requires inputs in the form of supplies, equipment, and maintenance. These inputs generate a boost in sales for those businesses providing these services and products. Moreover, the goods and services themselves require inputs for their production. The process continues as a large number of impacts recirculate through the economy. The total requirement for goods and services is the multiple of the initial needs of the petroleum industry-related establishments considered in this analysis; hence it is referred to using the term "multiplier."

Multiplier impacts were derived from the IMPLAN model. The multipliers used in this study were developed specifically to measure the economic impacts that occur within different sectors of the Minot, North Dakota regional economy. **Table A-2** summarizes the multipliers used for modeling the impacts of the firms within the petroleum industry categories considered in this analysis. For example, $100 in direct expenditures (output) in the professional services category supports a total output impact equivalent to $156. In this example, the multiplier impacts would be $56 ($156 minus $100). This methodology was applied to the direct impacts to generate estimates of total employment, annual payroll, and annual output for each petroleum industry category.

Table A-2: Minot Region IMPLAN Multipliers by Petroleum Industry Category

Petroleum Industry Category	Employment Multiplier	Payroll Multiplier	Output Multiplier
Oil and Gas Drilling, Extraction & Production	3.13	2.14	1.15
Infrastructure Development	1.90	1.42	1.40
Professional Services	1.79	1.60	1.56
Transportation	1.97	1.49	1.39
Wholesale Trade & Manufacturing	1.78	1.61	1.37

Source: CDM Smith and IMPLAN multipliers

Employment, Payroll, and Output Impacts of the Petroleum Industry

The results of this analysis indicate that the petroleum industry is a significant generator of economic activity in the Minot region and is projected to produce an increase in economic impacts annually through 2024. The petroleum industry helps to support jobs, payroll, and output for the regional economy. The following sections present economic impacts associated with employment, annual payroll, and total annual output for the petroleum industry categories as measured by this analysis.

Oil and Gas Drilling, Extraction, and Production

Direct, multiplier, and total impacts estimated for oil and gas drilling, extraction, and production activities for the period 2015 through 2024 are shown in **Table A-3**. The impacts are discussed by category below.

Table A-3: Economic Impacts for Oil and Gas Drilling, Extraction & Production Activities

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	3,166	3,448	3,900	4,579	5,314	7,179
Multiplier	6,733	7,332	8,294	9,738	11,301	15,267
Total	**9,899**	**10,780**	**12,194**	**14,317**	**16,615**	**22,446**
PAYROLL						
Direct	$401,538,000	$437,303,000	$494,629,000	$580,746,000	$673,964,000	$910,498,000
Multiplier	$458,726,000	$499,585,000	$565,076,000	$663,457,000	$769,952,000	$1,040,174,000
Total	**$860,264,000**	**$936,888,000**	**$1,059,705,000**	**$1,244,203,000**	**$1,443,916,000**	**$1,950,672,000**
OUTPUT						
Direct	$7,916,244,000	$8,621,354,000	$9,751,532,000	$11,449,298,000	$13,287,088,000	$17,950,318,000
Multiplier	$1,150,576,000	$1,253,059,000	$1,417,323,000	$1,664,083,000	$1,931,194,000	$2,608,965,000
Total	**$9,066,820,000**	**$9,874,413,000**	**$11,168,855,000**	**$13,113,381,000**	**$15,218,282,000**	**$20,559,283,000**

Source: CDM Smith and IMPLAN multipliers

Direct Impacts

As shown in **Table A-3**, direct impacts supported by the oil and gas drilling, extraction, and production category in 2015 included nearly 3,200 jobs earning more than $401.5 million in annual payroll, with an annual output of more than $7.9 billion.[88] By 2024, these figures are projected to increase to nearly 7,200 direct jobs earning nearly $910.5 million in annual payroll, with an annual output of nearly $18.0 billion.

Multiplier Impacts

Multiplier impacts are the employment, payroll, and output impacts created by ripple effects stemming from the direct impacts supported by oil and gas drilling, extraction, and production activities. As a result of these activities, additional multiplier employment is created in economic sectors such as limited- and full-service restaurants, hospitals, real estate, and maintenance and repair construction of non-residential structures. Multiplier impacts associated with oil and gas drilling, extraction, and production activities in 2015 accounted for more than 6,700 jobs in the Minot region; these employees received approximately $458.7 million in annual payroll. Annual output was nearly $1.2 billion. These impacts are estimated to increase to nearly 15,300 jobs, more than $1.0 billion in annual payroll, and more than $2.6 billion in annual output in 2024. These multiplier impacts are shown in **Table A-3**.

Total Impacts

For 2015, the total annual output (including direct and multiplier impacts) supported by oil and gas drilling, extraction, and production activities in the Minot region was nearly $9.1 billion. Total employment related to these activities was approximately 9,900 jobs, with a total annual payroll of nearly $860.3 million. By 2024, these figures are estimated to reach more than 22,400 jobs earning nearly $2.0 billion in annual payroll, with an annual output approaching $20.6 billion.

Infrastructure Development

Table A-4 presents the direct, multiplier, and total impacts estimated for infrastructure development activities for the period 2015 through 2024. These impacts are discussed below.

[88] Annual payroll in this analysis includes salary, wages, and benefits.

Table A-4: Economic Impacts for Infrastructure Development Activities

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	1,152	1,254	1,419	1,666	1,933	2,612
Multiplier	1,041	1,133	1,282	1,505	1,747	2,360
Total	**2,193**	**2,387**	**2,701**	**3,171**	**3,680**	**4,972**
PAYROLL						
Direct	$122,530,000	$133,379,000	$150,929,000	$177,190,000	$205,589,000	$277,815,000
Multiplier	$52,029,000	$56,636,000	$64,088,000	$75,239,000	$87,298,000	$117,966,000
Total	**$174,559,000**	**$190,015,000**	**$215,017,000**	**$252,429,000**	**$292,887,000**	**$395,781,000**
OUTPUT						
Direct	$397,726,000	$432,942,000	$489,907,000	$575,149,000	$667,331,000	$901,772,000
Multiplier	$157,355,000	$171,288,000	$193,826,000	$227,551,000	$264,021,000	$356,775,000
Total	**$555,081,000**	**$604,230,000**	**$683,733,000**	**$802,700,000**	**$931,352,000**	**$1,258,547,000**

Source: CDM Smith and IMPLAN multipliers

Direct Impacts

In 2015, infrastructure development activities supported direct impacts of nearly 1,200 jobs in the region, more than $122.5 million in annual payroll, and more than $397.7 million in annual output. The impacts generated by these activities are projected to increase to approximately 2,600 direct jobs earning more than $277.8 million in annual payroll in 2024. Annual output is estimated to increase to nearly $901.8 million.

Multiplier Impacts

Multiplier impacts generated by infrastructure development activities were estimated using IMPLAN multipliers. These impacts occur in economic sectors such as wholesale trade, full- and limited-service restaurants, hospitals, real estate, truck transportation, and retail stores. Multiplier impacts accounted for more than 1,000 jobs, approximately $52.0 million in annual payroll, and nearly $157.4 million in annual output in 2015, as presented in the table. By 2024, multiplier impacts are projected to account for nearly 2,400 jobs, nearly $118.0 million in annual payroll, and nearly $356.8 million in annual output.

Total Impacts

When direct and multiplier impacts were combined, the total employment impact supported by infrastructure development activities was estimated at nearly 2,200 jobs earning a total annual payroll of nearly $174.6 million in 2015. Total annual output was estimated at approximately $555.0 million. In 2024, total employment supported by infrastructure development approaches 5,000 jobs earning nearly $395.8 million in annual payroll. Total annual output is estimated at nearly $1.3 billion.

Professional Services

Direct, multiplier, and total impacts estimated for professional services activities for the period 2015 through 2024 are identified in **Table A-5** and are discussed below.

Table A-5: Economic Impacts for Professional Services Activities

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	745	811	917	1,077	1,250	1,689
Multiplier	590	642	726	853	990	1,338
Total	**1,335**	**1,453**	**1,643**	**1,930**	**2,240**	**3,027**
PAYROLL						
Direct	$45,647,000	$49,687,000	$56,187,000	$65,991,000	$76,589,000	$103,491,000
Multiplier	$27,225,000	$29,634,000	$33,510,000	$39,358,000	$45,678,000	$61,723,000
Total	**$72,872,000**	**$79,321,000**	**$89,697,000**	**$105,349,000**	**$122,267,000**	**$165,214,000**
OUTPUT						
Direct	$146,567,000	$159,537,000	$180,407,000	$211,887,000	$245,916,000	$332,295,000
Multiplier	$82,594,000	$89,902,000	$101,663,000	$119,403,000	$138,579,000	$187,255,000
Total	**$229,161,000**	**$249,439,000**	**$282,070,000**	**$331,290,000**	**$384,495,000**	**$519,550,000**

Source: CDM Smith and IMPLAN multipliers

Direct Impacts

As presented in **Table A-5**, direct impacts generated by professional services activities include more than 700 jobs earning more than $45.6 million in annual payroll, with an annual output approaching $146.6 million in 2015. These impacts are estimated to increase to nearly 1,700 direct jobs earning nearly $103.5 million in annual payroll, with an annual output of nearly $332.3 million by 2024.

Multiplier Impacts

Multiplier impacts generated by professional services activities are produced within economic sectors such as real estate, full- and limited-service restaurants, hospitals, retail stores, wholesale trade, and employment services. In 2015, multiplier impacts accounted for nearly 600 jobs earning more than $27.2 million in annual payroll and supported nearly $82.6 million in annual output. Multiplier impacts are projected to grow to more than 1,300 jobs, more than $61.7 million in annual payroll, and nearly $187.3 million in annual output by 2024.

Total Impacts

The total annual output (including direct and multiplier impacts) supported by professional services activities occurring within the petroleum industry was nearly $229.2 million in 2015, as identified in **Table A-5**. Total employment supported by these activities exceeded 1,300 jobs, with a total annual payroll approaching $72.9 million. By 2024, these impacts are projected to increase to nearly $520.0 million in annual output and more than 3,000 jobs earning more than $165.2 million in annual salary, wages, and benefits.

Transportation

The direct, multiplier, and total economic impacts estimated for transportation activities occurring within the petroleum industry in the Minot region are shown in **Table A-6**.

Table A-6: Economic Impacts for Transportation Activities

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	1,806	1,968	2,226	2,613	3,032	4,097
Multiplier	1,744	1,900	2,149	2,523	2,928	3,956
Total	**3,550**	**3,868**	**4,375**	**5,136**	**5,960**	**8,053**
PAYROLL						
Direct	$186,867,000	$203,629,000	$230,325,000	$270,368,000	$313,722,000	$423,917,000
Multiplier	$91,083,000	$99,254,000	$112,266,000	$131,783,000	$152,915,000	$206,627,000
Total	**$277,950,000**	**$302,883,000**	**$342,591,000**	**$402,151,000**	**$466,637,000**	**$630,544,000**
OUTPUT						
Direct	$687,681,000	$749,367,000	$847,607,000	$994,968,000	$1,154,513,000	$1,560,039,000
Multiplier	$270,708,000	$294,991,000	$333,663,000	$391,672,000	$454,477,000	$614,114,000
Total	**$958,389,000**	**$1,044,358,000**	**$1,181,270,000**	**$1,386,640,000**	**$1,608,990,000**	**$2,174,153,000**

Source: CDM Smith and IMPLAN multipliers

Direct Impacts

In 2015, transportation activities occurring within the petroleum industry supported approximately 1,800 direct jobs earning nearly $186.9 million in annual payroll. Direct annual output approached $687.7 million. These direct impacts are estimated to grow to nearly 4,100 direct jobs, nearly $424.0 million in annual salary, wages, and benefits, and nearly $1.6 billion in annual output in.

Multiplier Impacts

The direct impacts supported by transportation activities create ripple effects, which produce multiplier impacts within the Minot region's economy. Examples of economic sectors where these multiplier impacts are generated include wholesale trade, real estate, retail stores, full- and limited-service restaurants, hospitals, financial investment activities, and maintenance and repair construction of non-residential structures. In 2015, multiplier impacts resulted in more than 1,700 additional jobs having an annual payroll of approximately $91.0 million. Annual output exceeded $270.7 million. By 2024, this analysis estimates that multiplier impacts will increase to almost 4,000 jobs, more than $206.6 million in annual payroll, and more than $614.1 million in annual output.

Total Impacts

For 2015, the total annual output supported by transportation activities in the Minot region approached $958.4 million, which includes direct and multiplier impacts. These expenditures helped to support a total of nearly 3,600 jobs having an annual payroll of approximately $278.0 million.

These figures are projected to reach more than 8,000 jobs earning more than $630.5 million in annual payroll, with an annual output approaching $2.2 billion by 2024.

Wholesale Trade and Manufacturing

Table A-7 presents the economic impacts supported by wholesale trade and manufacturing activities related to the petroleum industry.

Table A-7: Economic Impacts for Wholesale Trade and Manufacturing Activities

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	796	867	980	1,151	1,335	1,804
Multiplier	624	680	768	902	1,046	1,414
Total	**1,420**	**1,547**	**1,748**	**2,053**	**2,381**	**3,218**
PAYROLL						
Direct	$53,426,000	$58,193,000	$65,774,000	$77,252,000	$89,606,000	$121,085,000
Multiplier	$32,535,000	$35,438,000	$40,055,000	$47,045,000	$54,568,000	$73,738,000
Total	**$85,961,000**	**$93,631,000**	**$105,829,000**	**$124,297,000**	**$144,174,000**	**$194,823,000**
OUTPUT						
Direct	$256,568,000	$279,457,000	$315,865,000	$370,985,000	$430,311,000	$581,484,000
Multiplier	$96,045,000	$104,613,000	$118,242,000	$138,876,000	$161,084,000	$217,675,000
Total	**$352,613,000**	**$384,070,000**	**$434,107,000**	**$509,861,000**	**$591,395,000**	**$799,159,000**

Source: CDM Smith and IMPLAN multipliers

Direct Impacts

Direct impacts generated by wholesale trade and manufacturing activities included nearly 800 jobs earning more than $53.4 million in annual payroll, with an annual output approaching $256.6 million in 2015. By 2024, these impacts are estimated to increase to approximately 1,800 direct jobs earning nearly $121.1 million in annual payroll, with an annual output of nearly $581.5 million by 2024.

Multiplier Impacts

Recirculation of the direct impacts generated by wholesale trade and manufacturing activities creates multiplier impacts in the Minot region's economy, which were estimated using IMPLAN multipliers. These impacts occur in economic sectors such as hospitals, full- and limited-service restaurants, real estate, truck transportation, retail stores, business support services, and monetary authorities and depository credit intermediation. This analysis estimated that these impacts included more than 600 additional employees, more than $32.5 million in annual payroll, and approximately $96.0 million in annual output. Multiplier impacts are projected to climb to more than 1,400 employees earning more than $73.7 million in annual salary, wages, and benefits by 2024. Annual output is estimated to reach nearly $217.7 million.

Total Impacts

In 2015, total impacts (direct and multiplier impacts) generated by wholesale trade and manufacturing activities occurring within the petroleum industry in the Minot region included more than 1,400 jobs, nearly $86.0 million in annual payroll, and more than $352.6 million in annual output, as presented in **Table A-7**. These impacts are estimated to grow to more than 3,200 jobs, more than $194.8 million in annual payroll, and nearly $800.0 million in annual output by 2024.

Total Economic Impacts of the Petroleum Industry in the Minot Region

Table A-8 combines the economic impacts shown in Tables 5-6 through 5-10 to summarize the total economic impacts of the petroleum industry in the Minot region for the period 2015 through 2024. As presented in Table 5-13, when all 2015 total employment, total annual payroll, and total annual output impacts for the petroleum industry activities considered in this analysis are summed, the petroleum industry:

- supported nearly 18,400 jobs (direct and multiplier)
- generated nearly $1.5 billion in annual payroll (direct and multiplier)
- produced nearly $11.2 billion in annual output (direct and multiplier)
- In 2024, the petroleum industry is estimated to:
- support more than 41,700 jobs (direct and multiplier)
- generate more than $3.3 billion in annual payroll (direct and multiplier)
- produce more than $25.3 billion in annual output (direct and multiplier)

Table A-8: Total Economic Impacts of the Petroleum Industry

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	7,665	8,348	9,442	11,086	12,864	17,381
Multiplier	10,732	11,687	13,219	15,521	18,012	24,335
Total	**18,397**	**20,035**	**22,661**	**26,607**	**30,876**	**41,716**
PAYROLL						
Direct	$810,008,000	$882,191,000	$997,844,000	$1,171,547,000	$1,359,470,000	$1,836,806,000
Multiplier	$661,598,000	$720,547,000	$814,995,000	$956,882,000	$1,110,411,000	$1,500,228,000
Total	**$1,471,606,000**	**$1,602,738,000**	**$1,812,839,000**	**$2,128,429,000**	**$2,469,881,000**	**$3,337,034,000**
OUTPUT						
Direct	$9,404,786,000	$10,242,657,000	$11,585,318,000	$13,602,287,000	$15,785,159,000	$21,325,908,000
Multiplier	$1,757,278,000	$1,913,853,000	$2,164,717,000	$2,541,585,000	$2,949,355,000	$3,984,784,000
Total	**$11,162,064,000**	**$12,156,510,000**	**$13,750,035,000**	**$16,143,872,000**	**$18,734,514,000**	**$25,310,692,000**

Source: CDM Smith and IMPLAN multipliers

Employment, Payroll, and Output Impacts of the Petroleum Industry's Non-Resident Workforce

As previously explained, a large number of employees in North Dakota's petroleum industry work in the state but live elsewhere. This is due to the unique nature of the oil and gas industry. For example, workers involved in oil and gas industry activities such as drilling, hydraulic fracturing (fracking), and infrastructure construction typically have alternating working and non-working periods. During the non-working periods, workers who are not residents of North Dakota will return to their permanent residence out of state. Because the objective of this analysis is to assess the petroleum industry's potential impact on the Minot region's future population, it was necessary to estimate the portion of economic impacts in Table 5-13 that can be attributed to non-resident workers, who are not included in the preferred population projections for the Minot region and the City of Minot.

A May 2016 research report prepared by NDSU's Department of Agribusiness and Applied Economics provides insight on the residency of North Dakota's oil and gas industry workforce. In their report *Assessment of the Oil and Gas Industry Workforce*, the study authors, Nancy Hodur and Dean Bangsund, sought to describe the current petroleum industry workforce in western North Dakota in terms of residency, job description, and industry activity. As part of their data collection effort, Hodur and Bangsund surveyed petroleum industry firms involved in activities similar to the categories of firms included in this analysis to identify workforce residency. They found that 60 percent of the workers at the surveyed firms were residents of North Dakota and 40 percent lived in neighboring states or elsewhere in the United States.

Based on these findings, this analysis estimated that 40 percent of the economic impacts in Table 5-13 can be attributed to non-resident workers. A breakout of these impacts produced by non-resident workers is provided in **Table A-9**. As shown in the table, the non-resident workforce in the petroleum industry in the Minot region in 2015:

- supported nearly 7,400 total (direct and multiplier) jobs
- generated more than $588.6 million in total (direct and multiplier) annual payroll
- produced nearly $4.5 billion in total (direct and multiplier) annual output

In 2024, the non-resident workforce in the petroleum industry is projected to:

- support nearly 16,700 total (direct and multiplier) jobs
- generate more than $1.3 billion in total (direct and multiplier) annual payroll
- produce more than $10.1 billion in total (direct and multiplier) annual output

Table A-9: Total Economic Impacts of the Non-Resident Workforce in the Petroleum Industry

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
EMPLOYMENT						
Direct	3,066	3,339	3,777	4,434	5,146	6,952
Multiplier	4,293	4,675	5,288	6,208	7,205	9,734
Total	**7,359**	**8,014**	**9,065**	**10,642**	**12,351**	**16,686**
PAYROLL						
Direct	$324,003,000	$352,876,000	$399,138,000	$468,619,000	$543,788,000	$734,722,000
Multiplier	$264,639,000	$288,219,000	$325,998,000	$382,753,000	$444,164,000	$600,091,000
Total	**$588,642,000**	**$641,095,000**	**$725,136,000**	**$851,372,000**	**$987,952,000**	**$1,334,813,000**
OUTPUT						
Direct	$3,761,914,000	$4,097,063,000	$4,634,127,000	$5,440,915,000	$6,314,064,000	$8,530,363,000
Multiplier	$702,911,000	$765,541,000	$865,887,000	$1,016,634,000	$1,179,742,000	$1,593,914,000
Total	**$4,464,825,000**	**$4,862,604,000**	**$5,500,014,000**	**$6,457,549,000**	**$7,493,806,000**	**$10,124,277,000**

Source: CDM Smith and IMPLAN multipliers

To estimate the economic impacts attributed to the non-resident workforce in the City of Minot, it was first necessary to estimate the economic impacts generated by non-resident workers in Ward County, where the City of Minot is located. According to data available from JSND's 2015 North Dakota Oil and Gas Employment Report, 46.5 percent of the petroleum industry workers in the Minot region worked in Ward County in 2015. This percentage was applied to the economic impacts for the Minot region in Table 5-14, which yielded the non-resident workforce economic impacts for Ward County in **Table A-10**. The table shows that in 2015 the non-resident workforce in the petroleum industry in Ward County:

- supported more than 3,400 total (direct and multiplier) jobs
- generated more than $273.5 million in total (direct and multiplier) annual payroll
- produced nearly $2.1 billion in total (direct and multiplier) annual output

In 2024, the non-resident workforce in the petroleum industry is projected to:

- support nearly 7,800 total (direct and multiplier) jobs
- generate $620.3 million in total (direct and multiplier) annual payroll
- produce more than $4.7 billion in total (direct and multiplier) annual output

JSND's 2015 North Dakota Oil and Gas Employment Report also shows that in 2015, 83.5 percent of the petroleum industry workforce in Ward County worked in the City of Minot. This percentage was applied to the economic impacts for Ward County in Table 5-15 to identify the economic impacts attributed to non-resident workers in the City of Minot. These impacts are presented in **Table A-11**, which reveals that in 2015 the non-resident workforce in the oil and gas industry in the City of Minot:

Table A-10: Total Economic Impacts of the Non-Resident Workforce in the Petroleum Industry

Ward County, 2015-2024

	2015	2016	2017	2018	2019	2024
Employment						
Direct	1,425	1,552	1,755	2,061	2,391	3,231
Multiplier	1,995	2,173	2,457	2,885	3,348	4,523
Total	**3,420**	**3,725**	**4,212**	**4,946**	**5,739**	**7,754**
Payroll						
Direct	$150,567,000	$163,985,000	$185,483,000	$217,772,000	$252,704,000	$341,432,000
Multiplier	$122,980,000	$133,938,000	$151,494,000	$177,869,000	$206,407,000	$278,868,000
Total	**$273,547,000**	**$297,923,000**	**$336,977,000**	**$395,641,000**	**$459,111,000**	**$620,300,000**
Output						
Direct	$1,748,198,000	$1,903,945,000	$2,153,524,000	$2,528,446,000	$2,934,207,000	$3,964,143,000
Multiplier	$326,650,000	$355,754,000	$402,386,000	$472,440,000	$548,238,000	$740,707,000
Total	**$2,074,848,000**	**$2,259,699,000**	**$2,555,910,000**	**$3,000,886,000**	**$3,482,445,000**	**$4,704,850,000**

Source: CDM Smith and IMPLAN multipliers

Table A-11: Total Economic Impacts of the Non-Resident Workforce in the Petroleum Industry

City of Minot, 2015-2024

	2015	2016	2017	2018	2019	2024
Employment						
Direct	1,189	1,295	1,465	1,720	1,996	2,697
Multiplier	1,665	1,814	2,051	2,408	2,794	3,775
Total	**2,854**	**3,109**	**3,516**	**4,128**	**4,790**	**6,472**
Payroll						
Direct	$125,670,000	$136,869,000	$154,812,000	$181,762,000	$210,918,000	$284,974,000
Multiplier	$102,644,000	$111,790,000	$126,443,000	$148,457,000	$172,276,000	$232,755,000
Total	**$228,314,000**	**$248,659,000**	**$281,255,000**	**$330,219,000**	**$383,194,000**	**$517,729,000**
Output						
Direct	$1,459,122,000	$1,589,115,000	$1,797,425,000	$2,110,351,000	$2,449,017,000	$3,308,646,000
Multiplier	$272,636,000	$296,928,000	$335,849,000	$394,319,000	$457,583,000	$618,226,000
Total	**$1,731,758,000**	**$1,886,043,000**	**$2,133,274,000**	**$2,504,670,000**	**$2,906,600,000**	**$3,926,872,000**

Source: CDM Smith and IMPLAN multipliers

- supported nearly 2,900 total (direct and multiplier) jobs
- generated more than $228.3 million in total (direct and multiplier) annual payroll
- produced more than $1.7 billion in total (direct and multiplier) annual output

In 2024, the non-resident workforce in the petroleum industry is projected to:

- support nearly 6,500 total (direct and multiplier) jobs
- generate more than $517.7 million in total (direct and multiplier) annual payroll
- produce more than $3.9 billion in total (direct and multiplier) annual output

Preferred Population Projections with Non-Resident Workers Included

To assess the petroleum industry's potential impact on the future population of the Minot region and the City of Minot, the direct and multiplier employment impacts identified in Tables 5-14 and 5-16 were added to the preferred population projections for the Minot region and the City of Minot for the 2015 to 2024 period, since non-resident workers (and therefore any associated multiplier impacts) were omitted from those forecasts. **Table A-12** presents the results of adding the non-resident workers and associated multiplier jobs from **Table A-10** and **Table A-11** to the preferred population projections. As shown in **Table A-12**, when non-resident worker population impacts are included, the Minot region's population is projected to increase at an AAGR of 2.3 percent from 2015 to 2024 (compared to 1.5 percent when those impacts are excluded). The non-resident workers and associated multiplier jobs add nearly 7,400 people to the Minot region's population in 2015 and nearly 16,700 people by 2024. In the case of the City of Minot, adding the non-resident worker population impacts results in the AAGR for the City's population to increase from 1.5 percent to 2.1 percent during the 2015 to 2024 period. Non-resident workers and multiplier jobs add nearly 2,900 people to the City's population in 2015 and nearly 6,500 people by 2024.

Table A-12: Preferred Population Projections with Non-Resident Petroleum Industry Workers and Associated Multiplier Jobs Included

Minot Region and the City of Minot, 2015-2024

	2015	2016	2017	2018	2019	2024	AAGR 2015-2019	AAGR 2015-2024
MINOT REGION								
Non-Resident Workers Excluded	103,380	105,775	108,225	110,731	113,296	118,606	2.3%	1.5%
Non-Resident Workers Included	110,739	113,789	117,290	121,373	125,647	135,292	3.2%	2.3%
Population Difference	7,359	8,014	9,065	10,642	12,351	16,686	13.8%	9.5%
CITY OF MINOT								
Non-Resident Workers Excluded	49,080	50,186	51,316	52,472	53,654	56,306	2.3%	1.5%
Non-Resident Workers Included	51,934	53,295	54,832	56,600	58,444	62,778	3.0%	2.1%
Population Difference	2,854	3,109	3,516	4,128	4,790	6,472	13.8%	9.5%

Source: 2016 North Dakota Statewide Housing Needs Assessment, prepared by the Center for Social Research and the Department of Agribusiness and Applied Economics at North Dakota State University; CDM Smith

What is important to realize is the non-resident petroleum industry workers added to the population projections in **Table A-12** will require public and private goods and services, such as housing, access to health care, police and fire protection, access to schools, and retail and entertainment options, even though they do not call North Dakota their permanent home. The multiplier jobs generated by the non-resident petroleum industry workers will likewise require these same goods and services.

Summary

North Dakota's oil and gas industry has experienced tremendous growth within the last ten years. This growth has brought a population surge as people have flocked to the state to take advantage of the employment opportunities created within this industry. The onslaught of new residents has strained public resources in communities in the state's western counties, and those communities have found it difficult to plan for the provision of future goods and services due to the volatility of oil prices and the unique nature of oil and gas industry workforce. Although the price of oil has dropped significantly since late 2014, which has resulted in a substantial slowdown in the state's petroleum industry, the North Dakota Department of Mineral Resources – Oil and Gas Division projects significant employment growth within the industry in the future.

This analysis estimated the economic impacts of the petroleum industry in the Minot region for the period 2015 to 2024 to assist public policy makers and economic developers as they plan for the future. Because recent population forecasts prepared for North Dakota did not include non-resident workers in the projections, this analysis provided a breakout of the economic impacts of the petroleum industry that are attributed to that industry's non-resident workers so those workers and associated multiplier jobs could be added to the preferred population projections selected for this analysis. This allows a clearer picture of the population that will require goods and services such as housing, access to health care, police and fire protection, access to schools, and retail and entertainment options.

Table A-13 summarizes the estimated economic impacts of the petroleum industry in the Minot region and the portion of those impacts that are generated by the industry's non-resident workers. As shown in Table 5-18, the petroleum industry accounted for the following total (direct and multiplier) economic impacts in 2015:

- Jobs – 18,397
- Annual Payroll – $1,471,606,000
- Annual Output – $11,162,064,000

Of these total impacts, it is estimated that non-resident oil and gas workers and associated multiplier jobs were responsible for:

- Jobs – 7,359
- Annual Payroll – $588,642,000
- Annual Output – $4,464,825,000

Table A-13: Economic Impacts of the Petroleum Industry and Non-Resident Workforce

Minot Region, 2015-2024

	2015	2016	2017	2018	2019	2024
TOTAL PETROLEUM INDUSTRY						
EMPLOYMENT						
Direct	7,665	8,348	9,442	11,086	12,864	17,381
Multiplier	10,732	11,687	13,219	15,521	18,012	24,335
Total	**18,397**	**20,035**	**22,661**	**26,607**	**30,876**	**41,716**
PAYROLL						
Direct	$810,008,000	$882,191,000	$997,844,000	$1,171,547,000	$1,359,470,000	$1,836,806,000
Multiplier	$661,598,000	$720,547,000	$814,995,000	$956,882,000	$1,110,411,000	$1,500,228,000
Total	**$1,471,606,000**	**$1,602,738,000**	**$1,812,839,000**	**$2,128,429,000**	**$2,469,881,000**	**$3,337,034,000**
OUTPUT						
Direct	$9,404,786,000	$10,242,657,000	$11,585,318,000	$13,602,287,000	$15,785,159,000	$21,325,908,000
Multiplier	$1,757,278,000	$1,913,853,000	$2,164,717,000	$2,541,585,000	$2,949,355,000	$3,984,784,000
Total	**$11,162,064,000**	**$12,156,510,000**	**$13,750,035,000**	**$16,143,872,000**	**$18,734,514,000**	**$25,310,692,000**
NON-RESIDENT WORKFORCE						
EMPLOYMENT						
Direct	3,066	3,339	3,777	4,434	5,146	6,952
Multiplier	4,293	4,675	5,288	6,208	7,205	9,734
Total	**7,359**	**8,014**	**9,065**	**10,642**	**12,351**	**16,686**
PAYROLL						
Direct	$324,003,000	$352,876,000	$399,138,000	$468,619,000	$543,788,000	$734,722,000
Multiplier	$264,639,000	$288,219,000	$325,998,000	$382,753,000	$444,164,000	$600,091,000
Total	**$588,642,000**	**$641,095,000**	**$725,136,000**	**$851,372,000**	**$987,952,000**	**$1,334,813,000**
OUTPUT						
Direct	$3,761,914,000	$4,097,063,000	$4,634,127,000	$5,440,915,000	$6,314,064,000	$8,530,363,000
Multiplier	$702,911,000	$765,541,000	$865,887,000	$1,016,634,000	$1,179,742,000	$1,593,914,000
Total	**$4,464,825,000**	**$4,862,604,000**	**$5,500,014,000**	**$6,457,549,000**	**$7,493,806,000**	**$10,124,277,000**

Source: CDM Smith and IMPLAN multipliers

In 2024, the total (direct and multiplier) economic impacts of the petroleum industry in the Minot region are projected to grow to:

- Jobs – 41,716
- Annual Payroll – $3,337,034,000
- Annual Output – $25,310,692,000

Of these total economic impacts, non-resident workers and associated multiplier jobs account for:

- Jobs – 16,686
- Annual Payroll – $1,334,813,000
- Annual Output – $10,124,277,000

Table A-14 presents the preferred population projections for the Minot region and the City of Minot with the total jobs attributed to non-resident workers and associated multiplier jobs from Table 5-18 included. As shown in the table, when non-resident workers and multiplier jobs are included in the NDSU's population forecast for the Minot region, the region's population could grow from approximately 103,400 people in 2015 to nearly 135,300 people by 2024. This growth represents an AAGR of 2.3 percent. When the non-resident workforce impacts are included in NDSU's population projection for the City of Minot, the City's population could grow from approximately 51,900 people in 2015 to nearly 62,800 people by 2024, representing an AAGR of 2.1 percent. In the case of the Minot region, the non-resident workers and associated multiplier jobs could add nearly 7,400 people to the region's population in 2015 and nearly 16,700 people in 2024. For the City of Minot, the non-resident workforce impacts could add nearly 3,000 people to the City's population in 2015 and nearly 6,500 people by 2024. It is important to note that all of these non-resident workers and associated multiplier jobs in the Minot region and the City of Minot require access to housing and other goods and services.

Table A-14: Population Forecasts for the Minot Region and the City of Minot with Non-Resident Petroleum Industry Workers and Associated Multiplier Jobs Included, 2015-2024

	2015	2016	2017	2018	2019	2024	AAGR 2015-2019	AAGR 2015-2024
MINOT REGION								
Non-Resident Workers Excluded	103,380	105,775	108,225	110,731	113,296	118,606	2.3%	1.5%
Non-Resident Workers Included	110,739	113,789	117,290	121,373	125,647	135,292	3.2%	2.3%
Population Difference	7,359	8,014	9,065	10,642	12,351	16,686	13.8%	9.5%
CITY OF MINOT								
Non-Resident Workers Excluded	49,080	50,186	51,316	52,472	53,654	56,306	2.3%	1.5%
Non-Resident Workers Included	51,934	53,295	54,832	56,600	58,444	62,778	3.0%	2.1%
Population Difference	2,854	3,109	3,516	4,128	4,790	6,472	13.8%	9.5%

Source: 2016 North Dakota Statewide Housing Needs Assessment, prepared by the Center for Social Research and the Department of Agribusiness and Applied Economics at North Dakota State University, and CDM Smith


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