McKENZIE COUNTY OIL INDUSTRY EXPERIENCE

HISTORY • TERMINOLOGY • MAPS • CHARTS

INTRODUCTION

There are approximately 1.8 million acres of land inside of McKenzie County's boundaries. Ragged buttes, prairie grasses, rivers and evolving terrain holds a history rich with fortitude, from the days of the roaming dinosaurs, through pioneering times, to the present state of worldwide connection, agricultural enhancements, fossil fuel development and community expansion.

McKenzie County has proven to be an economic powerhouse dating back to when it was inhabited by the native Hidatsa, Mandan and Arikara tribes. The arrival of Meriwether Lewis, William Clark and Sakakawea, made way for further exploration of the area in the form of trappers and cowboys, who, during the time of Theodore Roosevelt, were moving herds of cattle across the country by way of the Long X Trail to the banks of the Little Missouri River.

The influx of homesteaders in the early 1900s established the townships and grasslands. The 585 family owned farms and ranches that exist today ranks the county as one of the nation's top producers in beef cattle, durum and wheat. And 10,000 feet below the surface of these acres lays a natural resource that continues to put McKenzie County on the map as one of the leading oil producers in the nation.

We continue to hold close to the visionary spirit of the past while respecting the natural beauty and resources that exist inside our boundaries -a land that feeds us, fuels us, and inspires us to work toward a bright future.

CONTENTS

OIL AND GAS PRODUCTION

World oil production in 2019 averaged around 80 million barrels per day (bpd). The three largest producing countries include the United States of America, Russia and Saudi Arabia at 11.7, 11.2, and 10.5 million bpd respectively. The next group of six producers average between 2.9 and 4.5 million bpd. The US retook the top production spot in the fall of 2018 for the first time since 1973.

As of November 2018, Texas led US oil production at 4.8 million bpd followed by Federal Offshore production at 1.9 million bpd, North Dakota at 1.3 million bpd and then New Mexico at 803 million bpd according to the US Energy Information Agency (EIA).

OIL AND GAS INDUSTRY

The oil and gas industry can be broken down into three key sectors: upstream, midstream and downstream.

Upstream:
Exploration and Production

Upstream companies focus primarily on the exploration and location of oil and gas reserves and the subsequent drilling and production of oil and gas for sale to the commodities market.

Midstream:
Transportation, Storage, and Wholesale Marketing

Midstream companies provide the transportation, storage, and wholesale marketing of crude oil, natural gas and natural gas liquids (NGL's). Within the Bakken, gas processing plants are also considered part of the midstream sector.

Downstream:
Refining, Processing, Marketing, and Distribution

Downstream operations are those that take place after the production phase all the way to the point of sale. It includes those that process and refine products such as gasoline, petrochemicals, heating oil, lubricants, waxes, asphalt, and liquid propane.

DRILLING

FRACKING STIMULATION

UPSTREAM PRODUCTION

The Life of a Well

Drilling

Most of the oil production in North Dakota is from unconventional wells drilled in the Bakken formation containing a vertical well bore and a horizontal leg that traverses the Bakken formation for an average of two miles. Wells are drilled using large rigs that are capable of both rotary and horizontal drilling.

For the vertical section, a drillbit is connected to the drillstring, joints of pipe are assembled end to end, and the rig rotates the bit to cut, grind, and scrape through the underlying formations until it reached total vertical depth. Drilling stops periodically to line the well with carbon steel casing and cement as needed.

For the horizontal section, a drillbit is mounted to a mud motor where the drilling mud that is circulated through the drill stem turns the drillbit. The drillbit is "steered" by the engineer at the surface in what is called horizontal directional drilling.

In the early days of the Bakken starting in 2006, wells took over 30 days to drill. Today, with advances in drilling rig technologies and downhole tools, Bakken wells are typically drilled in 14 to 19 days. Most locations contain multi-well pads with four to twelve wells that are drilled in succession by rigs that can "walk" from one well bore to the next. This saves three to six days previously associated with moving a rig from one well to another.

Fracking

The Bakken shale is a tight rock formation with very low porosity and permeability that looks and feels like a slab of granite. The oil does not flow well naturally. Hydraulic fracturing or "fracking" is a means of breaking apart the formation and holding open the fissures with "proppant" – sand or ceramics.

After a well is drilled, millions of gallons of water, proppant, and fracturing fluids are injected under high pressure into the well. The pressure fractures the rock, allowing whatever hydrocarbons are in it to flow more freely and exit through the well. The proppant helps keep those cracks open, and the result is more natural gas and oil.

Top five producing operators in North Dakota:

Continental RESOURCES

HESS

COMPLETION AND PRODUCTION

RECLAMATION

Completion and Production

The completion process refers to the installation of equipment in the well to facilitate the flow of oil and natural gas out of the well. Completion equipment includes production tubing inserted in the well serving as the conduit for the hydrocarbons to flow to the surface. A wellhead—an assembly of valves, spools and instruments that controls the flow of fluids out of the well—is installed at the surface of the well.

The Bakken is an overpressured formation and initial production flows to the surface spontaneously – known as free-flowing. As pressure in the well subsides over time, artificial lift technology must be installed to bring the oil to the surface. Various technologies are used such as electrical submersible pumps (ESP), gas lift, and rod pumps – the conventional pumping unit that rocks up and down.

Overall production of a well includes primary recovery, secondary recovery, and tertiary recovery. Primary recovery refers to the period of production prior to any additional intervention from the operator. Secondary recovery is a production improvement process such as water flooding or refracking the well. Tertiary, or enhanced, oil recovery involves the injection of steam, gas, chemicals, or microbes to change the properties of the hydrocarbons in the reservoir making them easier to extract.

Project Tundra is a $1.3 billion initiative to capture CO2 from coal plants in North Dakota. The CO2 is pressurized and piped into the Williston Basin and injected into Bakken wells for enhanced oil recovery.

Plug and Abandon/Reclamation

When an oil well no longer contains sufficient hydrocarbons to justify the continuation of production operations, the operator fills in the well, dismantles and removes equipment from the site. The area is then reclaimed by planting native grasses and vegetation.

Operators

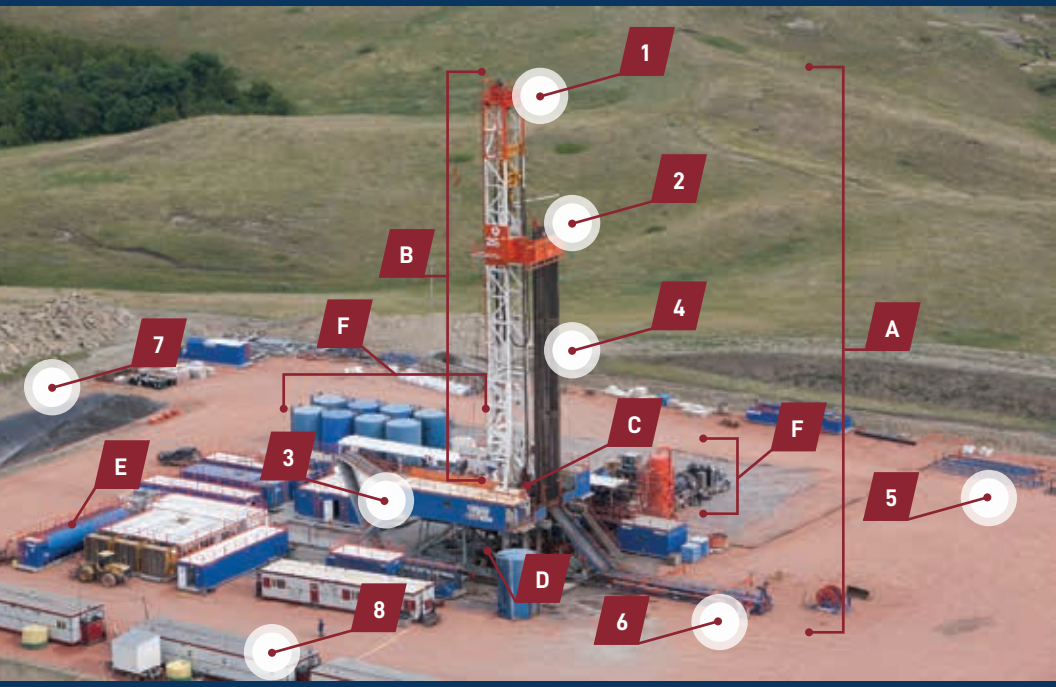
The operator, often referred to as the "oil company", is the company responsible for the exploration, development, and production of an oil or gas well or lease. There are about 120 operators producing in North Dakota with about 25 actively drilling new wells.

ConocoPhillips

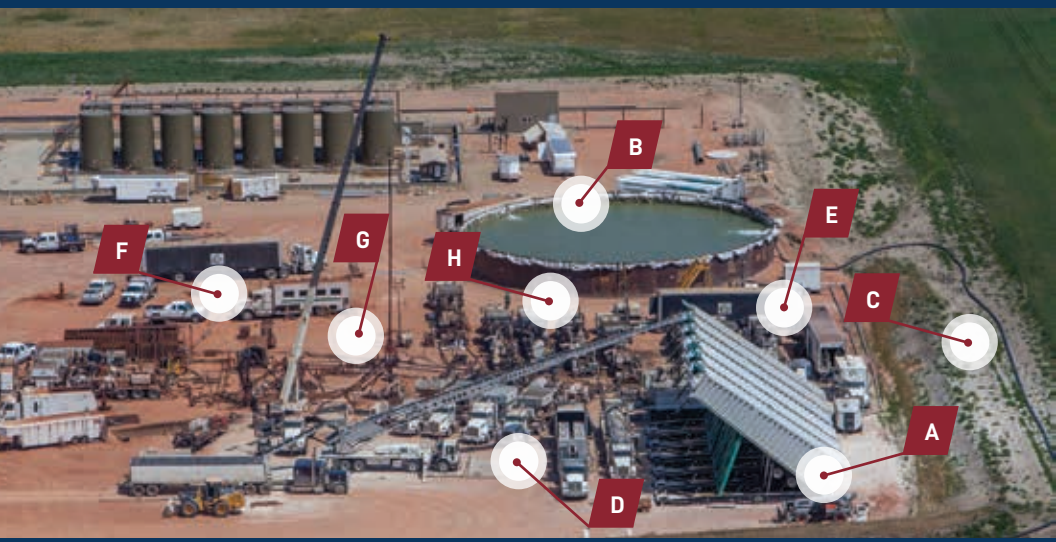
Chord Energy

Marathon Oil

DRILLING RIG SITE



FRACKING SITE



Rig Systems

- **A** **Tower Structure:** mast, derrick floor, bottom box, under structure
- **B** **Hoisting System:** draw works, crown block, travelling block, and drilling or casing line
- **C** **Rotary System:** swivel, rotary table, Kelly and bushing, drill stem, drill bit, etc.
- **D** **Well Control System:** well head, D-Spool, blow out preventer (bop), gas buster, accumulator, etc.
- **E** **Power System:** diesel engines and electrical motors and systems
- **F** **Mud System:** Mud tanks, mud pumps, pipes and flow lines, shale shaker, de-sander, de-silter, mud cleaner, agitator

Notable Components

1. **Crown**
2. **Racking Platform**
3. **Dog House**
4. **Drill Pipe**
5. **Pipe Racks**
6. **Hydraulic Catwalk**
7. **Pit**
8. **Crew Shacks**

The tower, hoisting, rotary, and well control systems make up the core of the rig to conduct drilling operations. The power system is a series of diesel engines generating electricity to power the electric motors for drilling and all electrical needs on location.

A combination of fluids, known as drilling mud, is continuously circulated downhole during drilling returning to the surface carrying drill cuttings, sand, and associated fluids which are then separated and resued.

Instrumentation systems enable monitoring and control of drilling operations, well pressure control, and geosteering among others. Geosteering, or directional drilling, uses mud motors and measure-while-drilling tools to adjust the wellbore to deviations of the formation.

Notable Components

- **A** Sand Storage
- **B** Water Storage
- **C** Water Transfer
- **D** Chem Truck
- **E** Blender
- **F** Data Van
- **G** Wellhead
- **H** Pump Trucks

Hydraulic fracturing is the process of blending water, chemicals, and proppant (sand or ceramic) then sending the fluid mixture downhole under extremely high pressure. This process cracks or fractures the geologic formation containing oil and gas enabling them to flow or be pumped to the surface.

The blender truck draws in sand, water, and chemicals from onsite storage to create the desired frack fluid formulation to effectively fracture and hold open raceways for oil and gas to flow. Though trucks are still used, water transfer has largely replaced truck hauling to bring fresh water on location.

Pump trucks, the blender truck, and the well head are connected by a series of iron pipes which provide the high pressure needed to pump the fluid downhole, sometimes exceeding 9,000 psi. The data van houses the control center that monitors wellhead pressure, pumping pressure, fluid composition, and other aspects of the fracking operation.

UPSTREAM PRODUCT AND SERVICE SUPPLY CHAIN

Upstream operations comprise much of the oil and gas activity in the Williston Basin. While the hundred-plus oil and gas operators drive activity, they contract with **thousands** of providers in the upstream product and service supply chain to drill, complete, and produce wells and bring the oil and gas to market.

While there are many people employed with the operators, there are exponentially more companies and people employed with the service companies whom the operators contract with for services.

Three key areas of the oil and gas supply chain include:

- **Oilfield Service Companies**
- **Commodities**
- **Transportation and Logistics**

Oilfield Service Companies

Oilfield service company is a broad term applied to any company contracted by an oil and gas operator providing the people, equipment, and services needed to drill, frack, complete, and produce oil and gas wells.

Service companies range in size from the largest multinational firms with tens-of-thousands of employees, such as Schlumberger and Halliburton, to the sole-proprietors and smaller firms. They also range in breadth of services from a single activity such as centrifuge dewatering to multiple divisions with many service lines. Enclosed is a small sampling of the hundreds of different service providers:

- Seismic
- Land Services
- Architects, Engineers, Surveyors
- Drilling
- Downhole Tools and Consulting
- Hydraulic Fracturing
- Flowback
- Trucking and Rental Equipment

Drilling:

- Nabors
- H&P
- Precision
- Cyclone
- Patterson

Fracture Stimulation:

- Schlumberger
- Halliburton
- Cal Frac
- Liberty Oilfield Services

Various Area Service Companies:

- Stallion Oilfield Services
- Basin Concrete – Trucking and Rental
- Select Energy Services
- E&M Oilfield Services – Roustabout, Well Site Construction & Maintenance
- Youngquist Brothers Oil & Gas
- Weatherford

- Casing Crews
- Wireline
- Well Service
- Water Disposal
- Roustabouts
- Rig Movers
- Crane Services
- Machining and Welding

UPSTREAM PRODUCT AND SERVICE SUPPLY CHAIN

Commodities

In the past twelve years, North Dakota has gone from 3,638 producing wells to 15,979 producing wells, an average of over 1,000 wells per year.

Large volumes of materials are used in the oil and gas industry including:

- Drill Pipe
- Casing
- Frac Sand and Ceramic Proppant
- Aggregate
- Water
- Cement
- Chemicals

DRILL PIPE

AGGREGATE

Bakken wells are drilled to an average of 27,000 feet. The well bore is lined with steel casing and cement to protect the formation and carry fluids to the surface. The process uses thousands of tons of steel and cement each year.

Hydraulic fracturing blends high volumes of water with proppant and chemicals. A Bakken well requires 1 to 5 million gallons of water. The North Dakota Department of Mineral Resources estimates that 20 to 30 million gallons of water a day, or 7.3 billion to 11 billion gallons of water a year will be needed over the next few decades. The DMR also estimates that well completions require about 4,000 to 5,000 tons of sand or ceramic proppant.

FRAC SAND CONTAINERS

Transportation and Logistics

With the Bakken encompassing 200,773 square miles and the high volume of commodities used in oil development, transportation, and logistics are critical for moving tons of commodities, materials, equipment, and people needed.

Trucking

Trucking is used to haul commodities and materials into as well as around the Williston Basin. There are an estimated 2,000 truck movements for each well drilled. A Commercial Driver's License (CDL) is a high demand skill required to drive most of the trucks in the industry.

Rail

Rail is considered the most efficient method for moving large amounts of commodities and materials in and out of the Williston Basin. Numerous unit train and rail spur facilities were constructed to serve these needs.

A **rail spur** is typically a smaller secondary track used to load and offload railcars. A **unit train** has cars that all carry the same commodity, typically about 100 cars, and are more efficient than mixed cargo trains.

Truck Type	Sample Usage
Flatbed	Pipe/Casing, Drilling Mud, General Equipment
Heavy Haul	Drilling Rig Components, Construction Equipment
Winch Trucks	Skid-Mounted Tanks, Job Trailers, Compressors, etc.
Pneumatics	Ceramic Proppant, Sand, Bulk Materials
Oil Tankers	Crude Oil
Water Tankers	Water
Hotshot	Courier of the Oilfield

OIL TANKER

CRUDE-BY-RAIL AND TRANSLOADING FACILITY

Transload facilities efficiently transfer large volumes of commodities from rail to truck – often using standardized containers instead of transferring in bulk. **Crude-by-rail** facilities provide storage and loading of crude to ship oil to distant markets.

RAIL SPUR: FRAC SAND, CHEMICALS, DRILLING MUD, DRILL PIPE

MIDSTREAM

Midstream activities include the transporting, storing, processing, and marketing of oil, natural gas, and natural gas liquids. Bakken wells produce oil, gas, and associated water, called produced water that must be transported from the well to gathering and processing points and ultimately on to destination markets.

Crude Hauling and Gathering Systems

Trucking is the most flexible method for transporting oil and produced water from a well site location to a storage facility, albeit more costly than using a pipeline. Crude hauling by truck will always be a critical part of the Bakken, regardless of the amount of pipeline developed.

Pipeline gathering systems are consider the most cost-effective, reliable, and safe transportation option but take longer to site and develop. Gathering systems often include lines to transport oil, produced water, and natural gas.

Saltwater Disposal

The produced water in the Bakken is a high saline brine that is primarily disposed of in a Salt Water Disposal well and injected underground in a sandstone layer known as the Dakota Formation.

Gas Processing Plants

At the gas processing plant, methane — or dry natural gas — is separated from the wet natural gas, leaving natural gas liquids such as propane, ethane, and butane as by-products. The midstream companies then fraction, transport, and market these liquids.

Gas processing capacity in the Bakken is an ongoing challenge as plant development continues to lag growth in natural gas production. Billions of dollars have been invested in the past decade with billions more underway and in planning stages.

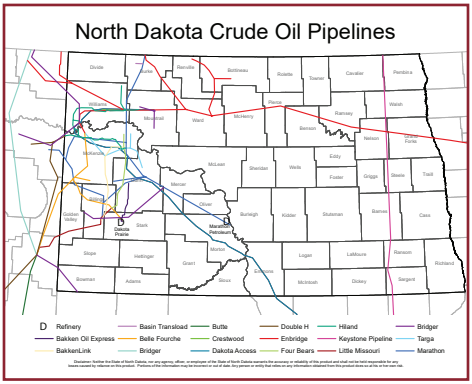
Takeaway Capacity – Transmission Pipelines, Rail and Truck

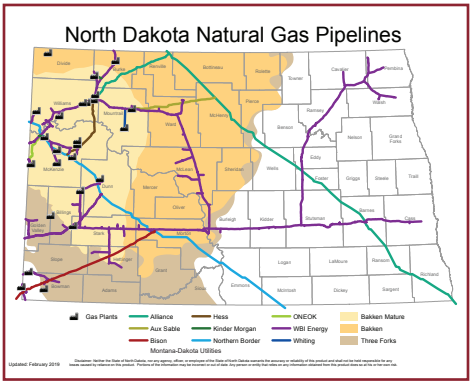
Transmission pipelines in the Bakken transport crude oil along routes to storage facilities and refineries in Minnesota, Chicago, Illinois, Cushing, Oklahoma, and further on to refineries on the east coast and gulf coast.

Rail was a critical part of takeaway capacity in the early Bakken boom as transmission pipeline capacity was significantly below the growing production levels. Numerous crude-by-rail facilities were developed including the COLT facility and those by Hess, EOG, Phillips, Statoil (now Equinor) and Bakken Oil Express. Though more costly, rail remains a viable option for its flexibility to reach markets not accessible by pipeline such as the west coast.

Midstream Companies in the Bakken:

- Oneok
- Kinder Morgan
- Enbridge
- Plain All American Pipeline
- True Cos.
- Summit Midstream
- Bakken Oil Express
- Caliber Midstream
- Tesoro
- TransCanada





DOWNSTREAM

Downstream operations are the processes that covert oil and gas into their finished products. These entities are closest to the end users of petroleum-based products. There are several core products created by refining and fractioning oil and gas including dry and wet gases, liquid fuels, lubricants, paraffin wax, slack wax, sulfur, bulk tar, asphalt, petroleum coke, and petrochemicals feedstocks.

Petroleum-Based Products

These core products are used as inputs to thousands of additional products. Petroleum-based products touch nearly every part of our daily lives in products ranging from gasoline, fuels and lubricants, to heating oil, plastics, synthetic rubber, antifreeze, fertilizers, pesticides, beauty products, waxes and petrochemical feedstocks.

HISTORY OF OIL IN NORTH DAKOTA

Overview

Oil production in North Dakota began in 1951 and reached an average of 115k barrels of oil per day (bopd) by January of 2007. Just over seven years later, on June 17, 2014, North Dakota oil production surpassed **one million** bopd thanks to development of the Bakken shale formation.

Basic Geology

Three geological elements are required for the creation of an oil and gas field: source rock, reservoir rock, and cap rock. Over millions of years, organic matter in the source rock is cooked into petroleum and natural gas. A mixture of oil, natural gas, and salt water then slowly migrates upwards, over thousands of years, through permeable layers of rock.

North Dakota Stratigraphic Column/*Courtesy of ND Department of Mineral Resources*

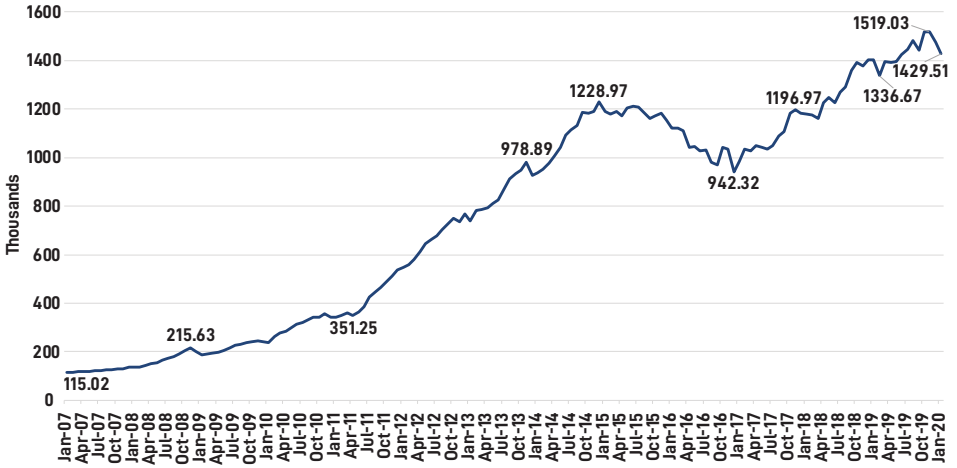
Clarence Iverson Discovery Well Monument/ *Located 10 miles south of Tioga*

An oilfield forms when the hydrocarbons (oil and gas) accumulate in a porous, permeable reservoir rock with an impermeable layer above it, which prevents further upward migration. In oil and gas production, a well punctures through the cap rock, enabling oil and gas to flow or be lifted to the surface.

Discovery of Oil in North Dakota

Geologists had for many years in the early twentieth century speculated that the Williston Basin in western North Dakota could produce oil. The **Clarence Iverson #1** discovery well was spudded on September 3, 1950 by the Amerada Petroleum Corporation. Oil officially first flowed on April 4, 1951, ushering in the first oil boom of the North Dakota.

Average Daily Oil Production



About 35 miles south of the Iverson discovery well and 22 miles east of Watford City, Amerada completed the **Risser Well No. 1** on March 27, 1952. It was the second well completed in North Dakota, and the first in McKenzie County.

Bakken Formation Wells

The Bakken formation was identified in the early 1950s along with the discovery of oil in North Dakota. The earliest producing wells of the Bakken shale formation were drilled in the early 1950s on Henry O. Bakken's farm less than five miles from the Clarence Iverson No. 1 well beginning with the **HO Bakken #1**. Exploration and production companies attempted to produce wells from the Bakken for many decades with mixed and mostly disappointing results.

Risser Well No. 1/*Courtesy of The Pioneer Museum of McKenzie County*

HO Bakken #1/*William E. (Bill) Shemorry Photograph Collection (State Historical Society of North Dakota) 10958-0033-000-00390*

WHY THE BAKKEN BOOMED

The Bakken Shale

Occupying about 200,000 square miles within the Williston Basin, the oil shale of the Bakken formation is one of the largest contiguous oil formations assessed by the US Geologic Survey. But historically, petroleum industry efforts to extract shale oil using conventional vertical wells had proven difficult.

Porosity and Permeability

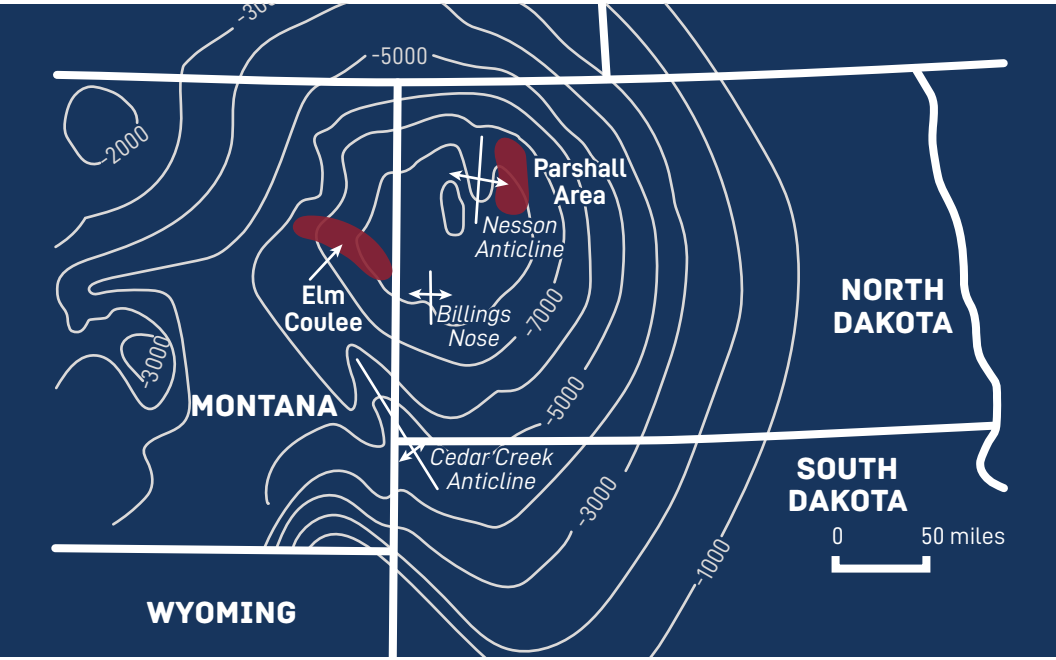
Porosity and permeability are related properties of any rock or loose sediment and key to oil and gas development. Porosity consists of the tiny spaces in the rock that hold the oil or gas. Permeability is a characteristic that allows the oil and gas to flow through the rock.

The Bakken formation is comprised of three layers – the upper, middle, and lower members. The upper and lower members are organic-rich shales with low permeability. The middle member is a dolomite composed of siltstone and sandstones with higher permeability but low porosity.

Jackie Lorentz Photo/*University of North Dakota Division of University and Public Affairs*

Conventional and Unconventional

Unconventional oil is petroleum produced or extracted using techniques other than the conventional vertical oil well. Unconventional oil production is commonly seen as more costly than conventional and, in most cases, is much less efficient. Examples include the Canadian oil sands and horizontal drilling.



In the late 1970s and early 1980s, activity picked up in the upper Bakken. In 1987, Meridian Oil drilled its first horizontal well in the Bakken's upper shale. Horizontal drilling occurred along the Bakken Fairway with mixed results, peaking in 1992 and ending in 2000.

The Elm Coulee Field

Undaunted by the failure of horizontal drilling in the upper shale Richard Findley, member of the Bakken play of the 1990s, believed the combination of **horizontal drilling** and **hydraulic fracturing** (fracking) could be applied to the porous middle member of the Bakken. The approach had been used in the Barnett Shale of Texas in the late 1990s with apparent success though data was not readily available for analysis.

The first horizontal well, the Burning Tree State #36-10, was drilled in late 1999 and subsequently fracked, ushering in discovery of the Elm Coulee field and economical production of the Bakken formation. Since the field discovery, more than 600 horizontal wells have been drilled and more than 200 million total barrels of oil have been recovered from Elm Coulee.

Parshall-Sanish Discovery

Mike Johnson, a petroleum geologist in Denver, examined the well log of an old dry hole drilled near Parshall, ND on the eastern boundary of the Bakken formation. He noticed the Bakken interval looked similar to that of the Elm Coulee field. Having secured a lease for the area, he partnered with EOG Resources to drill what became the Parshall #1-36H discovery well in June 2006.

EOG began completing wells capable of producing over 3,000 barrels of oil per day with estimated ultimate recoveries of 900,000 barrels. It was the discovery of the Parshall Field that set off the North Dakota oil boom.

Proliferation Throughout the Williston Basin

Soon after the Parshall discovery, operators began leasing acreage throughout the Williston Basin and finding commercial success with advanced techniques in horizontal drilling and hydraulic fracturing.

While development was successful throughout the basin, the economics were greatest near the center of the basin in the four core counties of McKenzie, Mountrail, Williams, and Dunn. Activity over the next decade plus would ebb and flow with the need to secure drilling leases and the price of oil.

Average Daily Oil Price—WTI

TECHNOLOGY AND INNOVATION

Horizontal drilling and hydraulic fracturing were key to unlocking the Bakken in the early 2000s. Numerous other developments during the ensuing years have increased production, reduced costs, and lessened impacts on area resources and infrastructure.

Horizontal Drilling and Hydraulic Fracturing

A traditional vertical well (Fig. 1, A) targets oil that migrates through a formation and pools into an area that traps the oil. Horizontal wells (Fig 1, B) have well bores that traverse laterally through a formation providing more contact with oil sources.

The vertical segment is drilled with a rotary drill stem and bit. Once at the kickoff point, the drill stem is fitted with a mud motor (Fig 2) and bit that contains an auger-type device inside. Drilling fluid (drilling mud) is forced down the drill stem through the mud motor turning the drill bit.

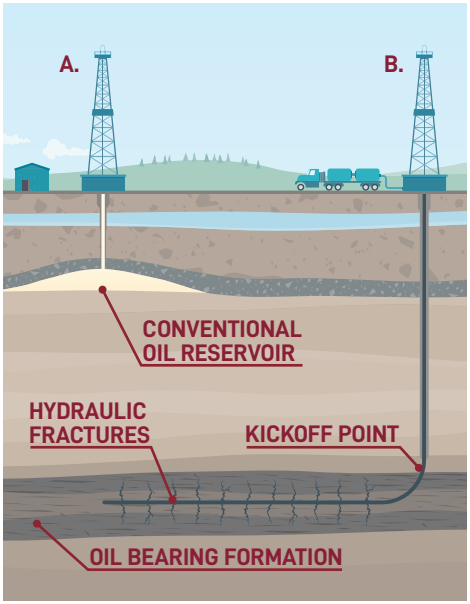


Figure 1/*Diagram of Vertical Well (A) and Horizontal Well (B)*

Figure 2/*Illustration of Mud Motor*

The ¾° fixed bent-housing causes the bit to veer in the direction of the bend. An operator controls the direction of the bit to determine the path of the well bore in a process that is called geosteering.

Hydraulic fracturing is the process of using downhole tools to perforate the horizontal well bore and then pumping highly pressurized fluid and proppant (typically sand or ceramic) through the lateral to crack, or fracture, the formation. The fractures, held open by the proppant, provide pathways for oil to move essentially increasing the permeability of the oil bearing formation.

The combination of horizontal drilling and fracking is referred to as unconventional exploration and production. This combination finally enabled the economically viable production of shale formations, such as the Bakken, often referred to as "tight oil".

Bakken wells have a steep decline curve (Fig. 3) where initial production volumes are high and then drop significantly in the first few years of their lifecycle. The industry focused on developing new technologies and processes to improve well performance, flatten the decline curve, and recover more oil from the formation, known as **estimated ultimate recover** (EUR).

Typical Bakken Well Production

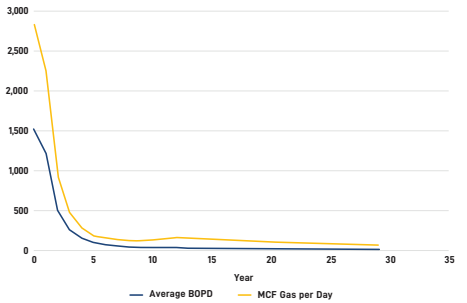


Figure 3/*Bakken well curve*

Multistage Fracking and Advanced Completions

The process of fracking a well is referred to as well completion, taking place after the well has been drilled. Advancement in well performance primarily revolves around frack and completion designs and techniques.

Early wells in the Bakken were fracked in a one stage process. Today, multistage fracking is reducing the fracking process to a section or stage at the far end of the lateral and then working back to the vertical well bore. In the middle 2000s many Bakken wells were fracked in 4 to 28 stages. Between 2009 and 2015 wells went from 28 to 50 stages.

Other advanced completion designs and technologies include larger amounts of water and higher concentrations of proppant and the use of diverters. Early frac examples used 98 gallons of fluids and 149 pounds of sand per foot. Recent designs used 1,100 gallons of slick water and 970 pounds of sand per foot with a combination of coarse and fine sands, as well as diverters.

A diverter, according to the Schlumberger oilfield glossary, is a chemical agent to ensure uniform injection over the area to be treated. These techniques and technologies are ever evolving to get the greatest production out of each well.

Water Transfer Photo/*Courtesy of Select Energy Services*

This includes lay flat hose and pumps from centralized locations, and stored on location in above ground frac pools or holding ponds.

Modular proppant handling systems such as SandBox Logistics have replaced bulk sand and ceramic proppant operations. The modular solution has reduced truck traffic, number of personnel on a frac site, and capital investment in various material handling equipment no longer needed. It also eliminates silica dust particles by eliminating multiple transfer points improving safety and reducing environmental impact.

These two innovations alone have reduced tens-of-thousands of truck movements lessening the impact on roads, reducing traffic congestion, and increasing traffic safety; not to mention the cost savings.

Water Transfer and Material Handling

Innovations in water transfer and material handling are among the numerous innovations that have significantly reduced costs for operators as well as minimized impacts on infrastructure and communities throughout the Bakken region.

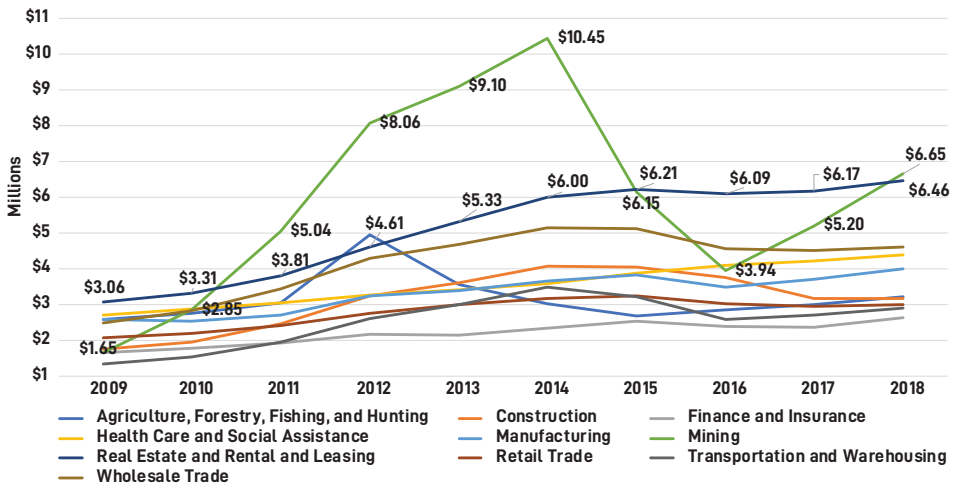
Millions of gallons of water are used in the fracking process. Initially water was hauled in numerous frac tanks and stored at each location. Water hauling trucks ensure a steady supply of water during fracking. Some frac tanks are still used but the majority of water is handled through "water transfer" operations.

Modular Sand Systems Photo

ECONOMICS

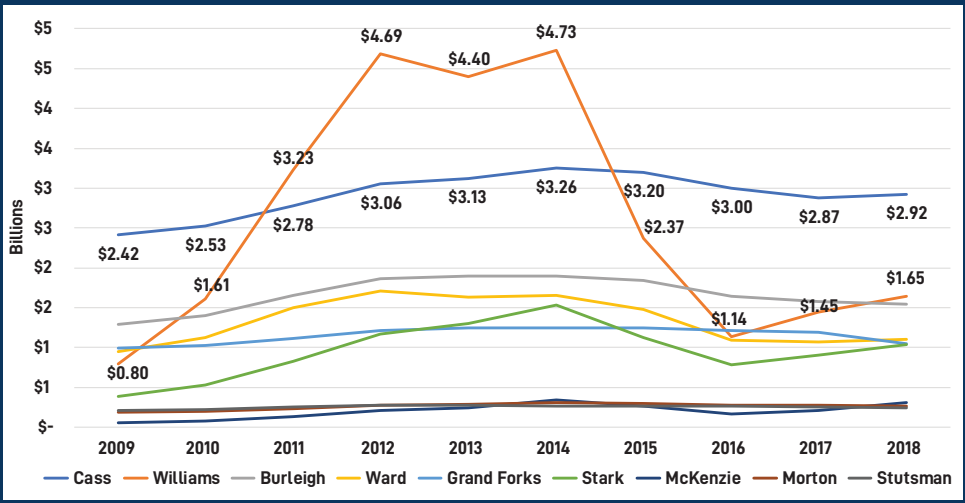
The oil and gas industry has been a key economic factor in western North Dakota since the discovery of oil in 1951. It has also grown in overall economic importance for the entire state of North Dakota since development of the Bakken Shale Play in 2007.

North Dakota Gross Domestic Product by Industry



In 2005, North Dakota's total GDP was $24.41 billion and the oil and gas industry, notated as Mining, ranked as the 13th largest industry in North Dakota at $638 million. After discovery of the Bakken Shale in 2007, Mining peaked at the height of the boom in 2014 and ranked as the number one industry at $10.45 billion or 17.8% of the state's total $58.65 billion GDP. The price of oil corrected in 2014 causing a contraction that bottomed out in 2016 and began a period of growth. Mining once again led the state at $6.65 billion or 11.9% of total state GDP of $56.08 billion.

Taxable Sales and Purchases by County



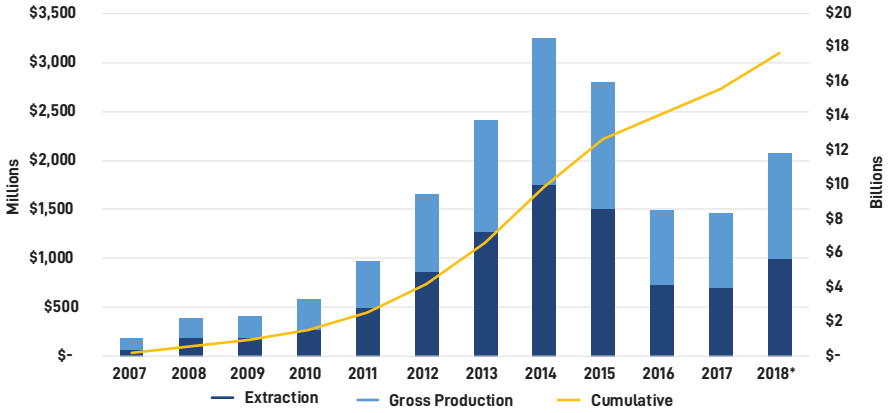
EMPLOYMENT AND WAGES

According to *Impacts of the Natural Gas and Oil Industry on the US Economy in 2015*, a study and report conducted by PwC for the American Petroleum Institute, the oil and gas industry accounted for 78,700 jobs in North Dakota, 13.3% of the state total.

Average Annual Wage as of 2018

United States	**$63,179**
North Dakota	**$49,620**
Grand Forks County	$48,825
Ward County	$51,740
Cass County	$53,248
Burleigh County	$54,340
Stark County	$64,688
McKenzie County	$79,456
Williams County	$82,524

Extraction and Production Taxes



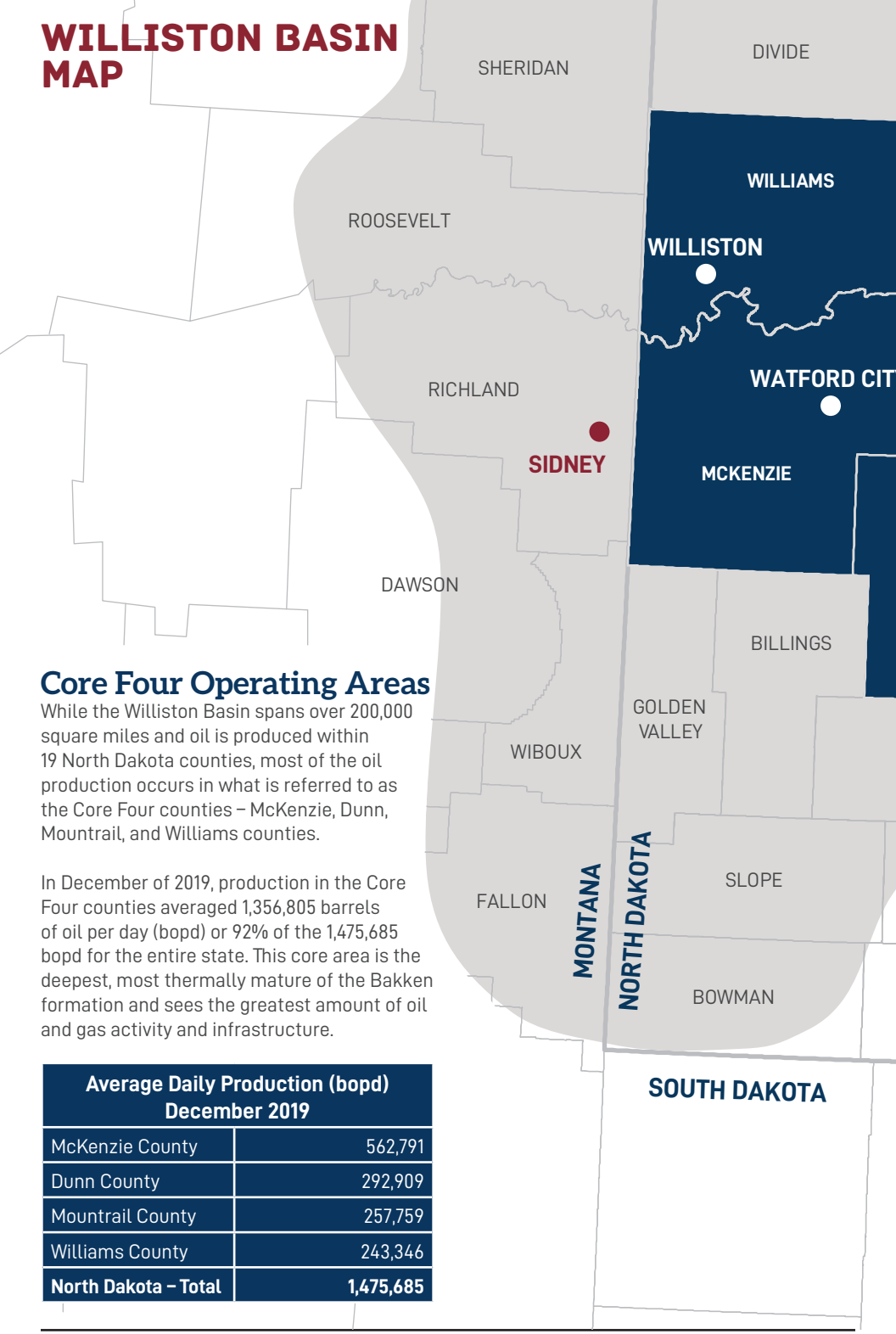
The intensity of taxable sales and purchases offer additional insight into the economic impact of the oil and gas industry in North Dakota. Sales tax collections in western North Dakota, particularly Williams and McKenzie counties at the epicenter of Bakken activity, are exponentially higher relative to other population centers in the state.

In 2012, Williams County's taxable sales and purchases were $4.68 billion relative to the population estimate of 24.4 thousand people. Comparatively, Cass County's (home to Fargo, the most populous city in the state) taxable sales and purchases were $3.05 billion relative to the population estimate of 156.8 thousand.

North Dakota assesses a 5.0% Extraction Tax for the severance of oil and gas as a natural resource. The state also assesses a 5.0% Gross Production Tax (GPT) in lieu of local property taxes on oil and gas wells. A portion of the GPT is returned to local political subdivisions.

Between fiscal years 2008 and 2018, Extraction and GPT revenues totaled nearly $18 billion and represented more than 44% of all taxes collected by the state of North Dakota.

WILLISTON BASIN MAP

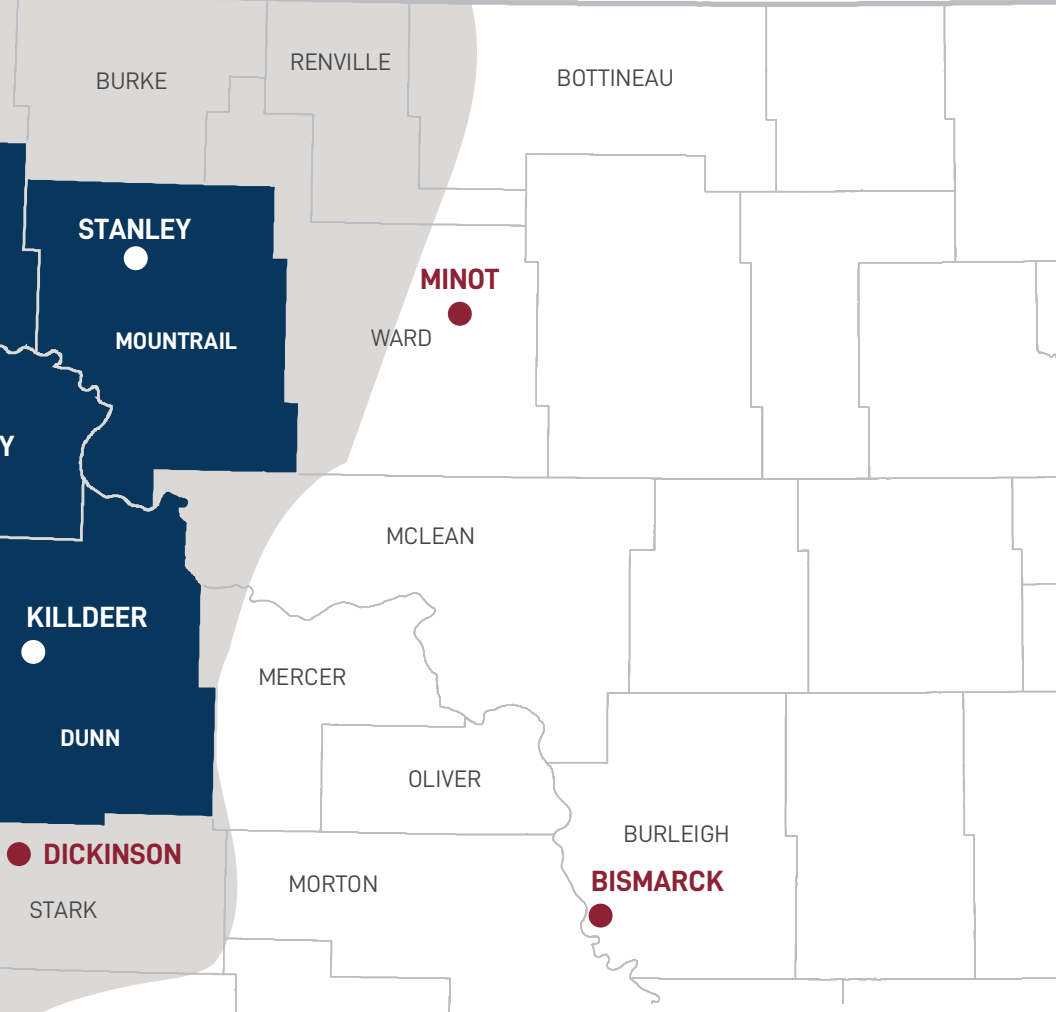


Core Four Operating Areas

While the Williston Basin spans over 200,000 square miles and oil is produced within 19 North Dakota counties, most of the oil production occurs in what is referred to as the Core Four counties – McKenzie, Dunn, Mountrail, and Williams counties.

In December of 2019, production in the Core Four counties averaged 1,356,805 barrels of oil per day (bopd) or 92% of the 1,475,685 bopd for the entire state. This core area is the deepest, most thermally mature of the Bakken formation and sees the greatest amount of oil and gas activity and infrastructure.

Average Daily Production (bopd) December 2019	
McKenzie County	562,791
Dunn County	292,909
Mountrail County	257,759
Williams County	243,346
North Dakota – Total	**1,475,685**



Population and Employment Centers

There are several communities that serve as the population and employment centers for the oil and gas industry in western North Dakota. Located in the heart of the activity, Watford City in McKenzie County was the most significantly impacted community by the Bakken Shale play, where the population grew from 5,713 in the 2010 census to an estimated 15,024 in 2019.

City/County	Population 2019 Estimate	Mining and Trucking Employment
Minot/Ward	67,641	3,257
Dickinson/Stark	31,489	4,601
Stanley/Mountrail	10,545	2,176
Killdeer/Dunn	4,424	935
Watford City/McKenzie	15,024	3,937
Williston/Williams	37,589	11,356

For more information about the McKenzie County Oil Industry Experience and other visitor services in the McKenzie County area, call or visit:

McKenzie County HERITAGE PARK

NORTH DAKOTA Oil MUSEUM

WATFORD CITY, NORTH DAKOTA

McKenzie County Heritage Park & North Dakota Oil Museum

904 2nd Ave SW/ PO Box 2197

Watford City, ND 58854

701-842-6434

mcheritagepk@gmail.com

Hours: Tuesday-Saturday 10am-5pm

mckenziecoheritagepark

Special thanks to:

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E&M Services
North Dakota Department of Mineral Resources
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University of North Dakota Division of University and Public Affairs Vern Whitten Photography
Western Dakota Energy Association