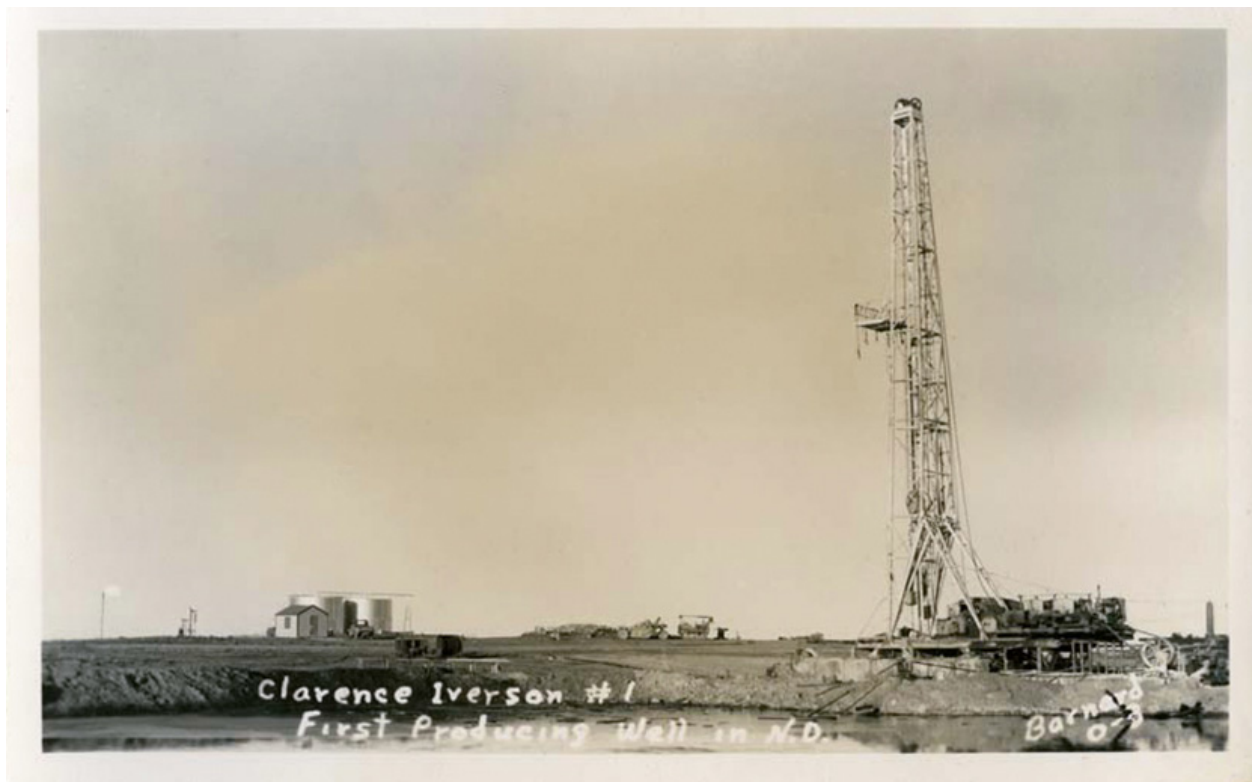


THE 75TH ANNIVERSARY OF THE DISCOVERY OF OIL IN NORTH DAKOTA

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On the Cover:

Photo of the Clarence Iverson #1 drilling rig. Image from the State Historical Society of North Dakota.

INTRODUCTION

On a cold April morning seventy-five years ago, a gas-oil separator was installed on the flare line of the Amerada Clarence Iverson No. 1 well. The resulting light oil that was produced ushered in the first successful oil well in North Dakota. This was the 25th permitted attempt to find economic oil in the state and its success touched off a flurry of leasing activity.

Amerada Petroleum Corporation's Clarence Iverson No. 1 Well (API#33-105-00004-00-00) in Williams County was spud on September 3, 1950, and on January 2, 1951, saw the first indications of oil on a drill-stem test (DST) from 10,448-10,803 feet MD from the Duperow Formation (Devonian) rocks, often referred to as "the first pint of oil". The well drilled ahead to 11,400 feet without additional shows when the driller switched the drill stem to a core barrel and collected well core down to final TD at 11,744 feet (Figure 1). A 5-1/2" casing was cemented in the well on February 26, 1951. The driller was instructed to test all possible shows in the well, so the first round of casing perforations were made from 11,678-11,720 feet, in the Interlake Formation and tested without success. That first set of perforations was squeezed off and a second round of perforations was made from 11,630-11,660 feet in the Interlake Formation (Silurian). This second test delivered 1,117 mcf/day (one thousand cubic feet) of natural gas and after an acid treatment the well produced 7,096 mcf/day of natural gas. The natural gas appeared to have an oil film, so a gas/oil separator was installed and on its first day of operation (April 4, 1951) the separator produced 307 barrels of oil in 17 hours with the well going on to produce 584,529 barrels of oil over its lifetime from a combination of the Madison Group, Duperow Formation, and Interlake Formation. A postcard photo of the drilling rig at the Clarence Iverson #1 site eight miles south of Tioga is shown in Figure 2. Fortunately, North Dakota State Geologist Wilson M. Laird working with four legislators, State Representatives George Saumur (Grand Forks), Walter Bubel (Center), Theodore O. Rohde (Van Hook / New Town), and State Senator Lars K. Morland (Scranton) had the foresight 10 years earlier to create a bill that significantly updated the statutes regulating oil development in the State of North Dakota.

Wilson M. Laird became the North Dakota State Geologist at the age of 26 years after having completed his Ph.D. at the University of Cincinnati (Figure 3). Originally from Pennsylvania, he moved to Grand Forks in 1940 to become a professor at the University of North Dakota (UND). For nearly 30 years he served as both the State Geologist and the Chair of the Geology Department at the University of North Dakota where he taught and mentored undergraduate and graduate students and did extensive field work around the world. He was remembered by Professor John Reid, 63 years after working with him in Alaska on the Martin River Glacier as a "good old boy" who focused principally on growing the North Dakota Geological Survey while having a more laissez-fair approach to chairing the Department of Geology. His work resulted in the growth of the North Dakota Geological Survey from a single



FIGURE 1. Core photo of Clarence Iverson #1 well core at 11,636 feet MD showing the pore space that produced the oil identified on April 4, 1951. Core stored in the Wilson M. Laird Core Library in Grand Forks, ND.

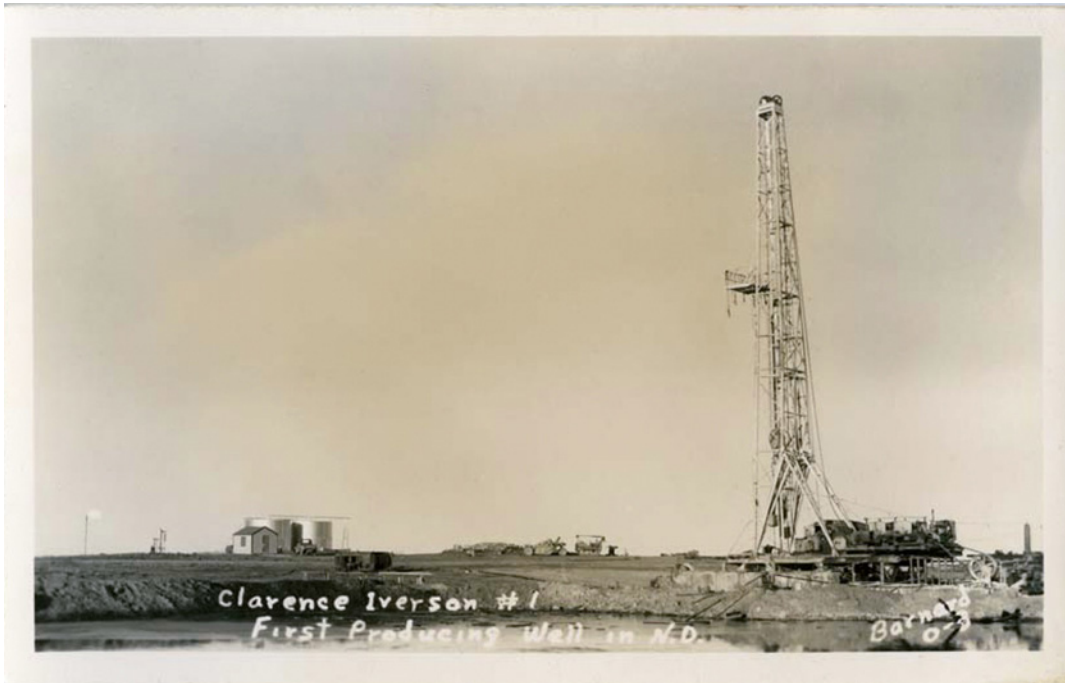


FIGURE 2. Photo of the Clarence Iverson #1 drilling rig. Image from the State Historical Society of North Dakota.

employee (himself) and an annual budget of less than \$3,500 in 1940 to an organization with 30 employees by 1970.

The first attempts at oil regulation in North Dakota were passed in 1911 and modified in 1929 and 1937. In late 1940, realizing that the existing laws were inadequate and impossible to administer, the North Dakota state legislature began deliberations on how to improve them. After only five months as the new North Dakota State Geologist, Wilson M. Laird was called to testify to the legislature on the need for and importance of creating a robust regulatory framework prior to oil discovery in the state. The law that was proposed was based on the "Model Act" of the Interstate Oil Compact Commission (now called the Interstate Oil and Gas Compact Commission), a multi-state compact formed in 1935 that had been created to prevent wastage of oil and gas, inefficient oil field development, and reservoir damage from excessive production rates. The pre-existing North Dakota Industrial Commission was set as the regulatory body with the state geologist as the commission advisor and enforcer of rules. The State Geologist was also authorized to require the preservation of critical well data including well (drill) cuttings and cores which were originally stored in unheated quonset buildings on the University of North Dakota campus, resulting in the creation of the Wilson M. Laird Core and Sample Library facility in 1980. These statutes were passed by the North Dakota legislature in late 1941. The first regulatory update

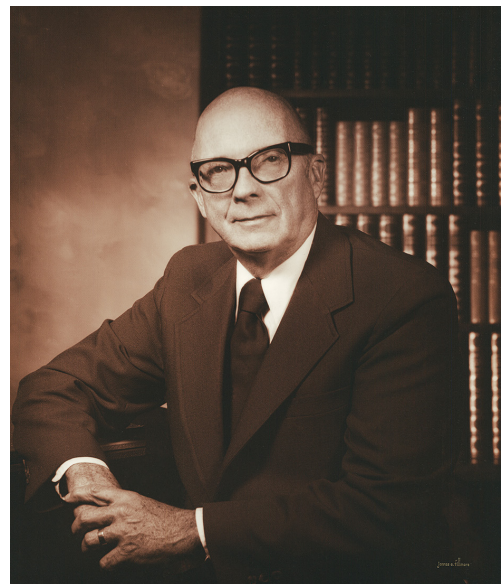


FIGURE 3. Wilson M. Laird, North Dakota State Geologist and University of North Dakota Geology Chair from 1941-1969. Photo from the North Dakota Geological Survey.

after the discovery of oil was championed by Clarence Burton "Burt" Folsom Jr., the Chief Petroleum Engineer for the North Dakota Geological Survey, to incorporate recent recommendations from the Interstate Oil Compact Commission. Additional significant regulatory updates have been made over the years, including better protections for correlative rights of adjacent mineral owners, more flexibility for improved development technologies, and a restructuring of the regulatory organization from the State Geologist to the Director of the Oil and Gas Division, and eventually the creation of the Department of Mineral Resources, which still today, is comprised of both the North Dakota Geological Survey and the Oil and Gas Division.

Wilson M. Laird published a vast number of articles over a wide subject range. In 1946 he published the Survey report "The subsurface stratigraphy of the Nesson anticline" (North Dakota Geological Survey Bulletin 21) pages 11-25, where he described the stratigraphy of the California Kamp No. 1, the first well to drill down into the Devonian Duperow Formation of North Dakota and the first well to provide drill cuttings, core samples, and well logs to the North Dakota Geological Survey. This report was the first published description of the subsurface geology along the flank of the Nesson Anticline and less than six miles from the future Clarence Iverson #1 well. In 1948, he and coauthor Larry Sloss received the American Association of Petroleum Geologists (AAPG) President's Award for their work on the Devonian formations of Montana. In 1981 he received the AAPG Public Service Award in recognition of his many years of contribution to the oil industry in technical, political, and public venues.

An excellent treatise on the first 50 years of commercial oil production in North Dakota can be found in "The 50th Anniversary of the Discovery of Oil in North Dakota" by John P. Bluemle, North Dakota Geological Survey Miscellaneous Series No. 89., 2001. When that publication was written, the author didn't mention new activity that was just starting across the border in Montana in the Elm Coulee Field. That play would soon completely revolutionize oil production in North Dakota.

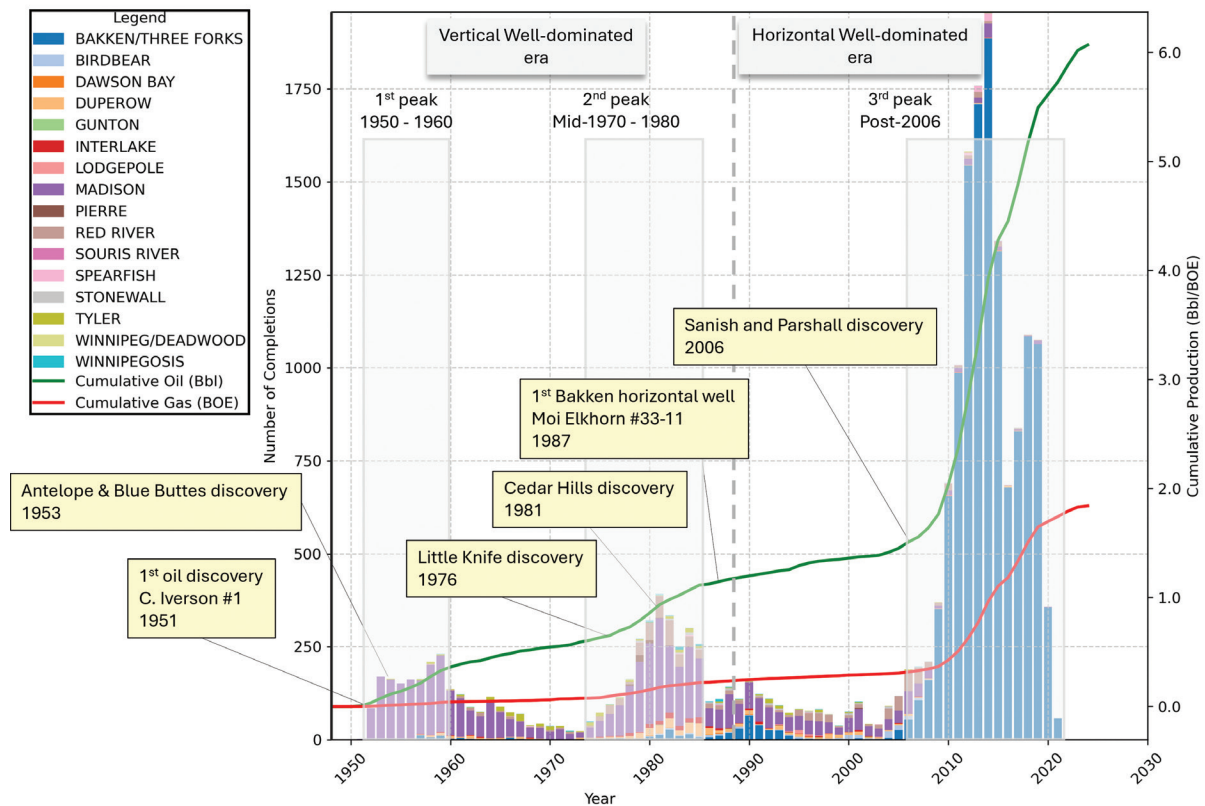


FIGURE 4. Creaming Curve for 1951-2020 Williston Basin Oil Production showing the number of well completions per year, broken down by producing interval, from Faruqi, I. H. (2026). Looking Beyond Giants: A Brief Creaming Curve Perspective for Post-Bakken/Three Forks Exploration in the Williston Basin, North Dakota. Geo Newsletter, 53(1), 8-11.

THE BAKKEN BOOM

Prior to 2001 and the 50th Anniversary of the Clarence Iverson No. 1 well, the Williston basin had permitted 15,020 oil wells in North Dakota. From 2001-2025 another 27,685 oil wells were permitted in the state, a nearly four-fold increase in well permitting rates since 2001 (Figure 4). The catalyst for this rapid growth were a few petroleum exploration geologists and engineers with the idea of combining the pre-existing technologies of horizontal drilling and hydraulic fracturing and applying them to the Bakken Formation, an otherwise overlooked rock known to be oil saturated but not economic to produce, and the ability to convince companies to invest in this new idea.

THE BAKKEN FORMATION

The Bakken Formation is named for the rocks described in the H.O. Bakken #1 (API#33-105-00005-00-00) well from a depth of 9,615 to 9,720 feet deep. This well, drilled by the Amerada Petroleum Corporation in Williams County, North Dakota was the 32nd permitted oil well in the state, spudded only three months after the success of the Clarence Iverson No 1. In this well, the Bakken consisted of a 25-foot-thick lower black shale, a 60-foot-thick mixed rock type middle layer, and a 20-foot-thick upper black shale. Another early Bakken well was the Gulf Oil Bennie-Pierre Federal #1 that was spud on September 4, 1955. This well identified the Bakken as an oil saturated rock with high oil generation, but its poor permeability resulted in a flow rate that was sub-economic. Additional vertical wells drilled during the 1970s and 1980s confirmed the widespread hydrocarbon presence along with the poor rock quality that meant it was a marginal or non-commercial resource.

The technologies that would result in the Bakken revolution over the last 25 years had their beginnings much earlier. Directional well drilling began in the 1920s as a method to drill around stuck downhole tools with one of the earliest controlled direction wells drilled in Texas in 1929. Technology rapidly improved in the 1970s with the creation of downhole mud-motors for steering, improvements in measurement while drilling (MWD) tools, and improved drill bits, resulting in the first commercial horizontal wells being drilled in the early 1980s in the North Sea and Austin Chalk Formation in Texas. Hydraulic fracturing was devised in the 1940s and became commercially available in 1949. The technology slowly grew with innovative improvements in hydraulic fracturing and proppant (to hold fractures open) from the 1950s to the 1970s. The key innovation to unlock hydraulic fracturing technology was the ability to multi-stage fracture and effectively stimulate the entire horizontal lateral. This technology was specifically invented for the Barnett Shale and the Bakken Formation in the early 2000s.

Looking back on the last 25 years of the Bakken revolution, it becomes clear that "Success has many fathers, but failure is an orphan" with many people contributing a small part to the success of this play. In this crowd, a few people stand out for their exceptionally important contributions.

The earliest Williston Basin studies would be the critical basis for all later work. Examples include Wilson M. Laird's work on the Nesson anticline (Laird, 1946), and his 1947 work with Larry Sloss on the Devonian system in Montana (Sloss and Laird, 1947). The Canadian part of the Williston Basin was investigated by Jim Christopher (Christopher, 1961). These papers formed the regional understanding of the Williston Basin depositional system.

Fred Meissner was a United States Geological Survey



FIGURE 5. Fred F. Meissner, photo from "AAPG GeoLegends: Fred F. Meissner – Father of the Bakken: Years Ahead of His Time." <https://www.youtube.com/watch?v=hOaSBLJy1ac>

geochemist who identified the Bakken as a self-sourcing over pressured hydrocarbon system (Figure 5). His paper on the Bakken (Meissner, 1978) was a key publication where he integrated well data, geochemistry, mapping, fracture systems, and reservoir interpretation.

Leigh Price was a United States Geological Survey organic geochemist who argued that the Bakken shales had generated enormous volumes of oil. He proposed that the oil was largely retained within the formation itself (continuous accumulation concept). His work helped reframe the Bakken from just a source rock to a potential reservoir. One of his most influential works was Price and LeFever (1992) where he makes the case that recent Bakken and Three Forks low productivity wells were producing oil that was self-sourced from the Bakken.

His coauthor on that paper, Julie LeFever, was also an early advocate of the Bakken Formation (Figure 6). A North Dakota Geological Survey geologist from 1989 until her death in 2016, she became a leading expert on Bakken stratigraphy, lithology, thermal maturity, and structural framework. She helped define the Bakken as an unconventional resource play within a regionally extensive self-sourced petroleum system with productivity controlled by rock properties and stimulation effectiveness instead of conventional structural trapping. She worked tirelessly to get that message out with core analysis programs, public reports, workshops with operators, and basin-wide mapping projects and was affectionately referred to as “Miss Bakken” after publishing more than 50 Bakken papers.



FIGURE 6. Julie LeFever, photo from the North Dakota Geological Survey (NDGS).

In 2015, the Rocky Mountain Section of AAPG awarded the John D. Haun Landmark Publication Award to Leigh C. Price and Julie LeFever for their 1992 paper. Julie additionally received the 2017 Robert R. Berg Outstanding Research Award from AAPG for her work on the Bakken Petroleum System.

BREAKTHROUGH: ELM COULEE (2000)

Oil had been produced from the Bakken Formation as early as 1953 when Stanolind Oil and Gas drilled the Woodrow Starr No. 1 well that was the discovery well for the 44-well Antelope Field. In 1961, Shell drilled the Government 41X-5-1 well in Billings County, discovering the 65-well Elkhorn Ranch Field. In 1987 Meridian Oil drilled their first Bakken horizontal well with the #33-11 MOI-Elkhorn well. All of these wells shared a common key feature—natural fracture systems that allowed hydrocarbons to flow through otherwise tight rock. Unfortunately, the fractured rock fairways were very limited in scope and, as such, the Bakken was only a curiosity outside of these small development areas. Years later, the application of horizontal wells combined with multi-stage hydraulic fracturing would result in the 2001 discovery of the Elm Coulee Oil Field in eastern Montana.



FIGURE 7. Kirk Osadetz, photo from Carbon Management Canada, <https://cmcghg.com/about-us/our-team/>.

Kirk G. Osadetz was a geochemist with the Geological Survey of Canada who studied the spatial variation

of Bakken oils in the Canadian Williston Basin (Figure 7). Realizing that the Williston Basin in Canada was generally too cool to generate hydrocarbons he carefully analyzed oil found in Canada and matched those oil families to their sources. His findings were published in Osadetz and Others, 1994, where he demonstrates the link between Canadian Bakken oil and its source in the deepest part of the North Dakota portion of the Williston Basin, showing that the Bakken oil had migrated several hundred kilometers from where it had formed.

A few years later Dan Jarvie (Figure 8), an independent analytical geochemist applied Rock-Eval pyrolysis techniques to the Bakken to determine source rock potential, generated hydrocarbons, and amount of moveable oil within the Bakken, confirming its status as a resource play (Jarvie, 2001). Despite being published in a smaller journal (The Mountain Geologist) it soon caught the attention of oil explorers.



FIGURE 8. Dan Jarvie, photo provided by Dan Jarvie.

Richard Findley was an independent geologist instrumental in identifying the productivity of the middle Bakken (Figure 9). He claimed his success came from being in the “right spot for the wrong reasons” (McKee, 2007). In the early 1990s, Findley was prospecting in eastern Montana for the deeper Nisku (Birdbear) Formation target and noticed that every deep well had encountered oil in the Bakken in a 50-mile-wide area. He was able to convince Bobby Lyle, the CEO of Lyco Energy of Dallas, to partner with him. At first they re-entered existing deeper vertical wells and tried single stage hydraulic fractures within the middle Bakken that proved oil could be produced from the Bakken. Lyco then was able to get Halliburton to join as a partner to help with improving productivity. Halliburton had only just begun to hydraulically fracture wells in the Barnett Shale in Texas, but this was not publicly known at the time. Halliburton saw the potential that Lycos had outlined and thought that success would promote their nascent hydraulic fracturing business. The first horizontal well was the Burning Tree State #36-10—the discovery well for the Elm Coulee Field. Hole stability issues forced an early TD at only 1,000 feet lateral length. This well was initially perforated in three places (heel, middle, and toe) and produced for several months before being hydraulically stimulated using a single stage hydraulic fracture technique often referred to as a ‘Hail Mary’ frac. The increased production resulted in Lycos expanding to a three-rig continuous drilling program. The Elm Coulee Field proved that horizontal wells and single stage hydraulic fracturing could economically produce the extensive oil accumulation in the middle Bakken Formation and would go on to produce more than 100 million barrels of oil.



FIGURE 9. Richard Findley, photo from Hart Energy “Born in the Bakken”, <https://www.hartenergy.com/exclusives/born-bakken-187276/>.

NORTH DAKOTA EXPANSION (2006)

Denver based petroleum geologist Michael S. Johnson investigated old well logs in the Parshall area and noticed how similar the Bakken in the Parshall area looked to the Bakken in Elm Coulee.

Believing he had a second Elm Coulee play, he and a partner leased a large land position in the Parshall area. Since it had been more than 12 years since any Bakken well had been drilled in North Dakota, they had to approach 17 companies. On July 2005, before signing a deal with Michael S. Johnson, EOG Resources spudded a horizontal well near one of Johnson's key offset wells that resulted in a poor producer, though it is credited as being the discovery well for the general horizontal Bakken unconventional play in North Dakota. Willing to take further risks, EOG Resources approached Johnson and his partner about their prospect and ended up buying the entire 38,200-acre Parshall prospect in February 2006. After shooting 3-D seismic over the area, EOG began drilling the No. 1-36 Parshall well, adjacent to the 1981 Lear No. 1 Parshall dry hole. After drilling only 1,600 feet of horizontal they had to stop drilling due to extremely high reservoir pressures. After completion using the first multi-stage hydraulic fracturing in the Bakken, the No. 1-36 Parshall well came in producing 463 barrels of oil per day on a short 1,600 foot lateral and is the discovery well for the Parshall Field. This success sparked a rapid expansion in drilling (and the use of multi-stage fracturing) and attracted other independent operators to the area. Subsequent drilling would extend the play to over 2.7 million continuous acres.

USGS AND DMR RESOURCE ASSESSMENTS (2008, 2010, 2013, AND 2021)

Despite all the excitement created by the new play, by 2008 many investors and oil companies still doubted the early results that EOG Resources had been reporting from the Parshall Field. This changed with the 2008 USGS Bakken Assessment spearheaded by Rick Pollastro. Rick Pollastro was a geologist with the United States Geological Survey who studied the geochemistry of the Bakken Formation including thermal maturity, hydrocarbon generation, and petroleum migration and retention in tight reservoirs. He also helped create the workflows for USGS unconventional assessments leading the publication in 2008 of the Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Bakken Formation, Williston Basin, Montana and North Dakota (Pollastro and Others, 2008). This assessment showed an estimated 3.0-4.3 billion barrels of technically recoverable oil in the United States portion of the basin. It also characterized the Bakken Formation as the largest continuous oil accumulation assessed in the lower 48 states at that time and resulted in a dramatic increase in capital flow and investor confidence.

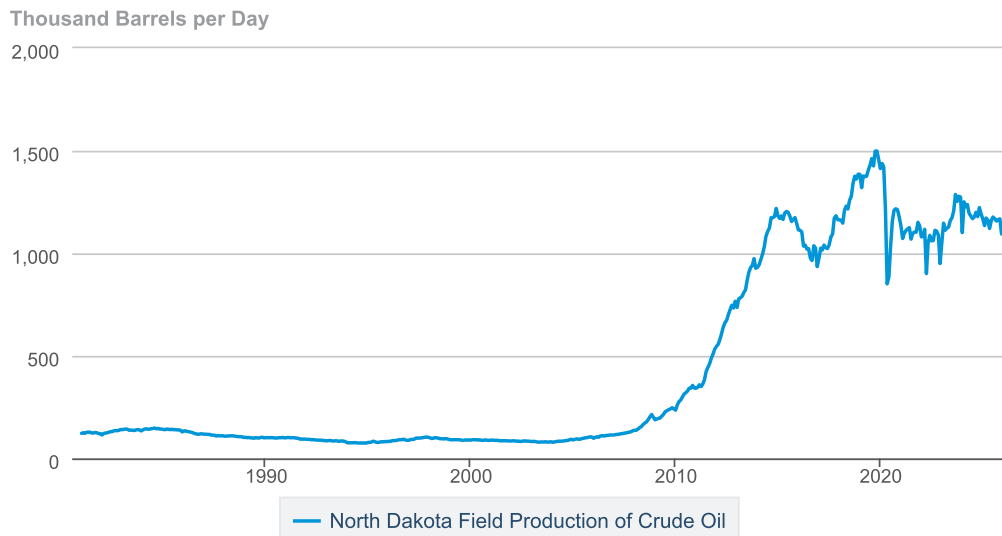
The USGS assessment came out two weeks before the 2008 Williston Basin Petroleum Conference in Minot, North Dakota, where the North Dakota Department of Mineral Resources (DMR) also released their assessment of the Bakken Formation in North Dakota. The DMR assessment had been completed several months earlier but the release was held back for the conference resulting in a sold-out conference weeks before it opened. With the sudden increase in mineral leasing and drilling activity along with the large 'official' estimated volumes released by both DMR and USGS, the Bakken was elevated to national strategic importance.

The USGS has continued to update their assessment work in the unconventional Bakken play with updates in 2013 and 2021. The 2008 report included the uppermost Three Forks Formation "Sanish Sand" as part of the Bakken assessment. The 2013 update separated the Three Forks assessment with 1,600 Three Forks wells drilled by that time and an additional 4,100 drilled by the 2021 assessment. A third target is the lowermost Pronghorn Member of the Bakken Formation that has a significantly smaller spatial area within the Williston Basin. As of the 2021 Assessment, the USGS has combined the Pronghorn Member with the Three Forks Formation due to indications of fluid communication between the two units.

PRODUCTION GROWTH (2010-2014)

The influx of capital resulted in rapid expansion of production in North Dakota going from 90,000 bpd in 2005 to 1.5 million bpd in 2020 (Figure 10) raising North Dakota to the 2nd largest state in oil production (it has since dropped to third place after the rise of New Mexico's portion of the Permian Basin).

North Dakota Field Production of Crude Oil



Data source: U.S. Energy Information Administration

FIGURE 10. North Dakota oil production from 1980-2025. Production levels stayed relatively flat from 1980-2007, ranging from 75,000 to 100,000 barrels of oil per day. From 2007-2020 production quickly rose from 100,000 barrels per day to 1.5 million barrels per day. After COVID production fell to 885,000 barrels per day but has since risen to 1.1 million barrels per day of oil production.

Rapid production growth came not only from greater investment, but also more operators, a much more rapid drilling intensity, and longer lateral lengths (from 5,000-10,000 foot wells that had much higher initial production rates). Multi-well pad developments with many wells drilled in more efficient 'batch-style' operations from a single surface well pad also resulted in much faster drilling rates.

As a result of the rapidly increasing production, the North Dakota GDP more than doubled from 2005 to 2014 (Figure 11). The sudden growth of oil field opportunities in very low population areas resulted in a severe labor shortage and rapid population growth in those areas. During the initial boom, housing costs in Williston ND exceeded that of New York City and San Francisco when the city's population more than doubled from 14,700 in 2010 to more than 30,000 in 2014. To recruit staff many companies built 'man camps' of modular units to house hundreds of workers.

Housing wasn't the only system strained by rapid growth. Infrastructure was also heavily impacted. Basin Electric Power Cooperative built new substations and transmission lines. The road network was improved to support higher levels of traffic and heavier oil-field trucking including major upgrades to U.S. Route 85, the major north-south road through the Bakken. The widespread use of hydraulic fracturing and the large volumes of high salinity produced-water required the creation of new pipelines, storage depots, waste-water disposal wells, and recycling facilities for waste-water. The existing pipeline infrastructure for moving crude oil quickly reached capacity requiring rail transport to move vast amounts of crude oil. At one point 70% of Bakken production in North Dakota was moved on unit trains that typically transported 70,000 barrels per train. Seventeen rail terminals were built across the Bakken to facilitate loading crude oil onto trains. Because Bakken crude oil typically has a higher concentration of volatile hydrocarbons, rail transportation can be risky. After several transport incidents, the North Dakota Industrial Commission implemented a new set of oil treatment

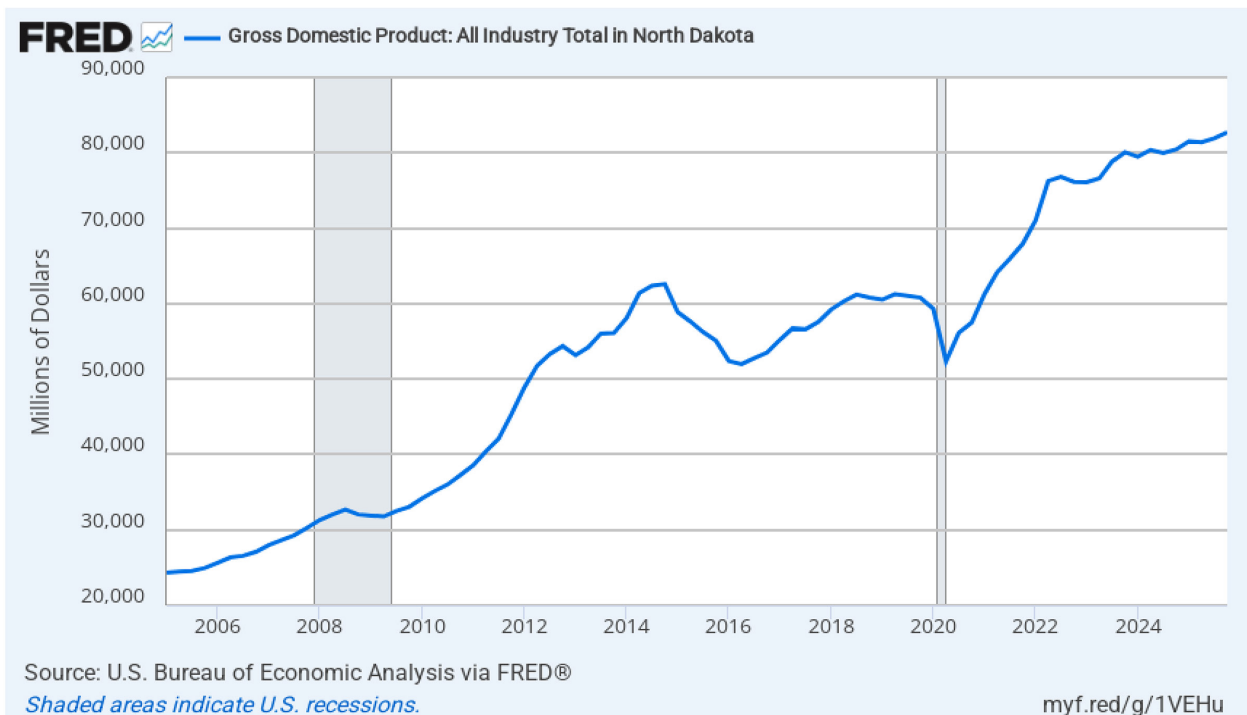


FIGURE 11. North Dakota quarterly GDP from 2005-2025. Statistics from the U.S. Bureau of Economic Analysis. North Dakota gross domestic product has been risen since 2005 when it was 24.3 billion dollars and is now 82.7 billion dollars, with a minor flattening of GDP during the 2008 economic crisis and another short-term drop during the COVID 19 crisis.

requirements on December 9, 2014 to reduce the amount of volatile components. This was followed by United States Department of Transportation rules from May 1, 2015 that required double-hulled rail cars (also called DOT-117 cars), automatic braking systems, and reduced speed limits in critical areas.

Pipeline capacity was added to the Bakken both to address the dangers of rail transport as well as improve the transportation economics. These include the 1,172-mile-long Dakota Access Pipeline (DAPL) completed in 2017 that moves up to 750,000 barrels per day of Bakken crude oil from North Dakota to Illinois and then to Gulf Coast refineries. The 826-mile-long Enbridge North Dakota Pipeline System (NDPL) goes from Plentywood, MT to Clearbrook, MN and from those points can send 355,000 barrels of oil per day to refineries in both Canada and the Midwest. A vast network of smaller connector pipelines was also built to connect rows of individual well pads directly to the larger regional pipeline systems.

One of the key people that helped the Bakken grow so quickly in North Dakota was Lynn Helms (Figure 12). Helms served as the Director of the North Dakota Oil and Gas Division (1998-2005) and the Department of Mineral Resources (2005-2024) where he oversaw regulation and policy during the rapid growth of the Bakken. Regulation included determining well spacing requirements and mandating gas capture. He also oversaw the regulation of crude vapor pressure standards to lower the risk of transporting Bakken crude on rail cars. He became one of the most vocal supporters of the Bakken through his role as



FIGURE 12. Lynn Helms, photo from the North Dakota Department of Mineral Resources.

Director, communicating with government, industry, and the public and speaking regularly about the positive impact that Bakken production was providing to the state.

Another influential person was Ron Ness who is the President of the North Dakota Petroleum Council (NDPC), the leading oil lobbying organization in the state of North Dakota (Figure 13). Ness has held the president role since 1999 and has served as a critical liaison between the oil companies, pipeline companies, oil-field service providers, lawmakers, regulators (the ND Department of Mineral Resources), and research institutions including the University of North Dakota's Energy and Environmental Research Center (EERC).



FIGURE 13. Ron Ness, President of the North Dakota Petroleum Council (NDPC), photo from NDPC.

The Williston Basin Petroleum Conference began as the Williston Basin Horizontal Well Workshop in 1993 by the North Dakota Geological Survey and Saskatchewan Energy and Mines as a means of sharing information on geology and emerging technologies across the international border.

The first conference was held in Minot, North Dakota with 170 attendees, and from then on was held in North Dakota on the even numbered years, with the exception of the Covid years. Ron Ness and the North Dakota Petroleum Council were brought in as conference partners in 2005. As a testament to Ron's managerial skills, conference attendance roughly doubled each time it was held in North Dakota from 2004 – 2012, starting at 257 and peaking at 4,250.

Finally, it should be noted that much of the success of the Bakken came from the support of John Hoeven, North Dakota governor from 2000-2010, and U.S. Senator since 2011. His support of business-friendly North Dakota regulations set the stage for success. Both North Dakota Governor Jack Dalrymple (2010-2016) and North Dakota Governor Doug Burgum (2016-2025 Secretary of the Interior since 2025), maintained and improved the Bakken momentum, with an emphasis on improving development technologies such as carbon capture and reduction of flaring. The other members of the Industrial Commission during this time, Agriculture Commissioners Roger Johnson (1997-2009) and Doug Goehring (2009-present) as well as Attorney Generals Wayne Stenehjem (2000-2022) and Drew Wrigley (2022-present), were equally supportive.

EFFICIENCY AND CAPITAL DISCIPLINE (2015-PRESENT)

The early rapid growth of the Bakken from 2001-2014 was becoming economically unsustainable, especially when the WTI oil price of \$106.7 in June 2014 crashed to \$32.74 in February 2016 (Figure 14). In reaction, successful operators shifted from a 'growth-at-all-costs' business model to a free cash-flow generation model focused on shareholder returns. Reduced rig counts that drilled longer lateral lengths (10,000 to 15,000 foot laterals) and improved optimization of completion design all worked to improve economics. A move toward 'manufacturing mode' development also resulted in the reduction of geoscience and engineering staff as a cost savings mechanism. As a result, when extremely low oil prices hit during the 2020 Covid crisis (\$19.23 in April 2020) most companies were already running at high levels of efficiency. An additional benefit of slower more controlled growth was a reduction in rents, a more manageable increase in population, and reduced stress on North Dakota's infrastructure.

THE NEXT 25 YEARS?

The next 25 years, like the last, will certainly be focused on innovation and technology. The technological and development successes in the Williston Basin over the past 25 years to get production levels to where they are currently won't provide the next 5 billion barrels without continued innovations in enhanced oil recovery, completion techniques, drilling improvements and more.

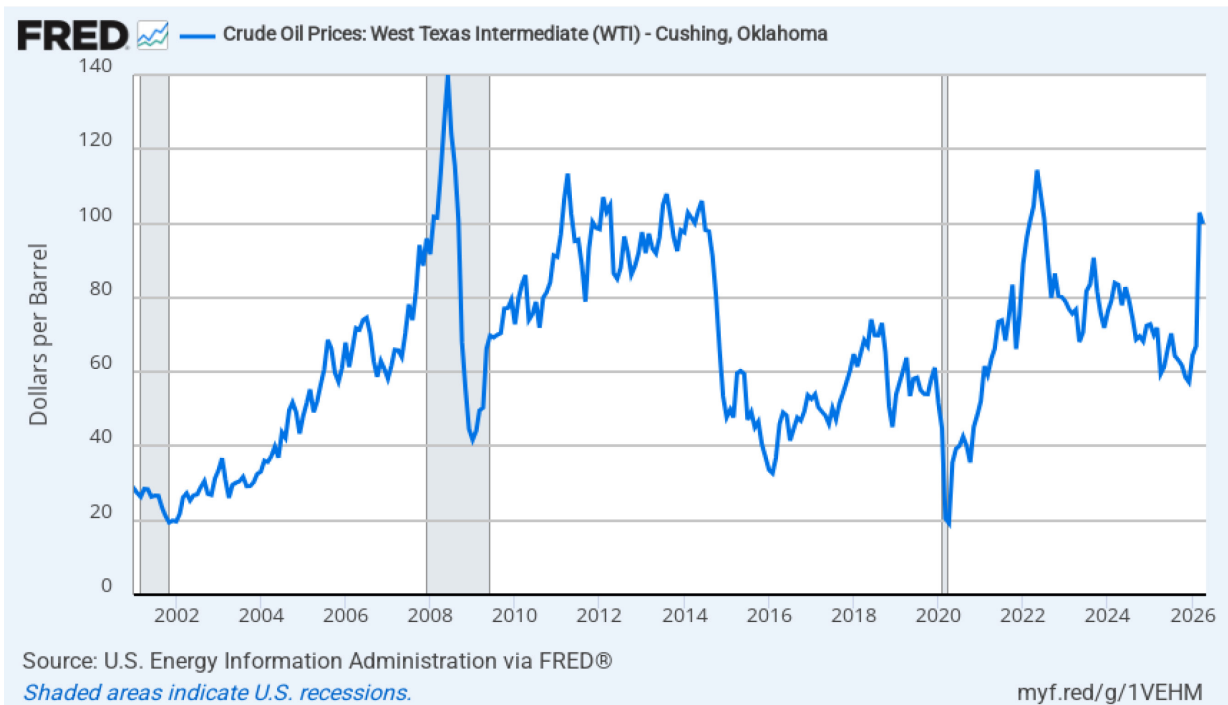


FIGURE 14. WTI Oil Price from 2001-2026. West Texas Intermediate oil price benchmarks have varied considerably during the 2001-2026 timeframe. From 2001-2008, WTI oil prices rose from \$19.91-139.96 per barrel. The 2008 economic crisis resulted in a rapid drop of WTI oil price down to \$41.73 per barrel. Prices slowly rose back to just over \$100 per barrel in 2014 before dropping back to \$60-70 per barrel until 2020. The COVID 19 crisis saw oil prices drop to \$19.23 per barrel, then steadily rose \$114.38 per barrel in May 2022 before slowing trending back down to \$57.26 a barrel in December 2025.

Recently drilled wells in the middle Bakken have begun to use four-mile lateral length wells and the North Dakota Department of Mineral Resources recently held a hearing on a development plan for 5-mile laterals. These wells have the advantage of reduced costs per unit length of reservoir by reducing the number of vertical sections, facilities, and well pads in half compared to a two-mile lateral. Despite approaching what is considered to be the maximum possible well length (two times the vertical depth) drilling and completions on these wells appear to be working extremely well, increasing well production and reducing per unit costs. These longer laterals appear to be economically successful even on the margins of the middle Bakken play. Additionally, complex well designs such as U-shaped and J-shaped horizontals are being implemented to efficiently produce oil in otherwise economically stranded acreage due to pre-existing suboptimal developments.

Other middle Bakken completion designs are being implemented across the border in Canada where they are not hydraulically fracturing the middle Bakken and instead producing through open-hole multilateral wells that are significantly less expensive.

The 'sister' play to the middle Bakken is the Three Forks, a formation located just under the Bakken. Although it is not as widespread as the middle Bakken, many operators have had excellent results with Three Forks infill drilling and completion programs that alternate existing middle Bakken laterals with Three Forks laterals. More than 6,000 horizontal wells have been drilled and completed in the Three Forks Formation to date.

Enhanced oil recovery (EOR) is often used in conventional oil fields using techniques including steam injection, using supercritical CO₂ fluid as a solvent, or using a surfactant to reduce surface tension to release oil into the produced solution. There are significant challenges to applying these technologies

on unconventional wells, but many trials are ongoing to modify these techniques for unconventional use.

There are still thousands of middle Bakken and Three Forks locations to develop however as existing middle Bakken wells reach the end of their economic life, additional opportunities in other younger plays like the Madison Group can be utilized by reanalyzing and testing behind-pipe shows in already drilled wells prior to plugging and abandoning them. Consolidation of leases in other basins like the U.S. Permian has made basin entry more difficult for smaller operators. Outside of the Bakken core development area there are likely many opportunities for smaller companies to make a basin entry.

It's also important to remember there are other potential resources within North Dakota's subsurface including critical minerals from coal and deep basin brines, helium, hydrogen, potential solution mining of potash, and geothermal, as well as long term CO₂ storage.

Wilson M. Laird was one of the only people who likely imagined the impact of the first oil on North Dakota in 1951. At the 50th anniversary no one could have foreseen the impact of unconventional development in North Dakota that was coming. Consider what the good people of North Dakota can accomplish in the next 25 years?

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