The Return of the Bakken

North Dakota’s production is setting new records, far exceeding the 2014 high. Bigger production volumes are coming from increasingly rubble-izing the rock.

North Dakota production figures during 2018—growing to a year-end exit rate of more than 1.4 million barrels a day (MMbbl/d)—defied some prognostications that the Williston Basin was on its way out. Rather, output from the Bakken and underlying Three Forks formations is on its way up.

It’s in the completions, really, operators say. Taylor Reid, president and COO for Oasis Petroleum Inc., said, “Yes, I remember a conference a few years ago where no one really cared about the Bakken. All everyone seemed to care about was the Permian. I opened my remarks saying that reports of the Bakken’s demise had been greatly exaggerated.”

At Oasis, good returns at $60 West Texas Intermediate (WTI) have resumed at even its leasehold on the Montana side of the basin.

Fifteen miles west of New Town, N.D., along state Highway 23 and turning north about 7 miles toward the foot of the Antelope Creek State Wildlife Management Area, Continental Resources Inc. completed 13 wells at its Tarentaise Federal pad in the fall of 2017, in McKenzie County. Combined, the wells have produced more than 3.1 million barrels (MMbbl) of oil through this past January.

In Dunn County, on the Mountain Gap pad, 31 miles south of Mandaree on Bureau of Indian Affairs Road 12 and 5 miles west on Gap Road, 10 wells were completed in the spring of 2018. Through this past January, the drilling-spacing unit (DSU) had produced 1.8 MMbbl.

In a DSU just northeast, the Brandvik 9-25H has made more than 141,000 bbl in its first 73 days online.

ARTICLE BY
NISSA DARBONNE

Completion operations in the Williston Basin were interrupted this past winter by extreme cold with some days at minus 20 degrees.
where the modern Bakken play began in 2000 in Elm Coulee Field. The Montana leasehold is back in Oasis’ “Top Tier” category.

The Williston Basin “continues to be a good place to do business,” Reid said. “It’s great to see the recognition the past couple of years really play out [in the production figures]. The Bakken is as good as any of these other shale plays—or better.”

The recipe

Until May of 2018, North Dakota’s December 2014 oil output continued to hold the No. 1 spot in state records at 1,227,483 bbl/d, set at the beginning of a plummeting oil price that tumbled all the way down to less than $30 WTI in February 2016. That was just a month before Reid spoke at that conference.

And the 2018 output was with a third (about 60) as many rigs as four years earlier.

Reid said that, besides advancement in the completion recipe in the Williston Basin, operators’ focus on core leasehold, lower oilfield service costs that are making bigger fracture-stimulation jobs less expensive, and a decline in oilfield service demand that means the best crews and best equipment are at work in the field have, contributed to improved output figures.

Helping too is an improved price for Bakken oil as the Dakota Access Pipeline came online in early 2017. Prior, differentials for Bakken oil could be as much as $10 less than the Cushing-WTI price.

On the completions side, jobs are pretty much 100% plug-and-perf (PP) today, with Hess Corp. even quitting sliding sleeves (SS) in 2018 as the cost of a PP job declined.

So what’s in that recipe? Chris Nichols, Continental’s Northern region completions manager, said, “We used that downtime, with slower activity after 2014, to tailor our completions and evaluated what was working in different areas. Since then, we’ve transitioned from an enhanced completion to more of an optimized completion. Some of our drivers are perf-cluster spacing, volume of fluid and proppant per perf-cluster.”

The stage interval has become a bit more optimally designed to create more fractures, more entry points and amount of fractures in a wellbore. Proppant is a finer mesh too. “The majority is 100-mesh, depending on the job, and the actual volumes of sand are bigger, too. We went from a 4-million-pound job to now averaging 10 million pounds and with finer-mesh proppants.”

Stages have grown from 36 to 50 in a 10,000-foot lateral. “And, then, the cluster-spacing is also tighter. The sets of perforations are about 25 feet apart now, where they used to be 50 to 75 feet apart. So we are doubling and tripling the entry points and amount of fractures in a wellbore.”

The pumping rate has grown to as much as 90 bbl per minute vs. 30 to 35.

“And then we’re also doing all cemented liners, all plug-and-perf, so all this is really designed to create more fractures, more complexity, really breaking up the rock and doing it more near-wellbore instead of making a frac that goes way out. We’re just really trying to rubble-ize the rock around the wellbore.”

Sleeve to perf

Barry Biggs, Hess Corp. vice president, onshore production, said the journey to reduce costs and improve productivity in the Bakken began in earnest in late 2010 but came into sharp focus in 2014 with the onset of a lower oil price. “Prices collapsed. You saw us, along with everyone else in the industry, really trying to figure out, ‘How are we going to make money?’”

Many operators transitioned to PP completions. “At Hess, we took a different approach and one based on doing everything possible to drive cost out of the system,” Biggs said.

Hess stayed with SS completions but started to aggressively implement its “lean manufacturing” method. Specifically, Hess increased sleeves from 30 to 60, while its well spacing was closer together than other operators’ intra-DSU well spacing.

Well costs declined about 40% in that two-year timeframe. “Hess wells were about $4.8 million cheaper than our competitors’ [wells],” Biggs said.

Other operators’ PP jobs may have been getting higher production, but, to Hess, it wasn’t worth the additional cost. “Our mantra was to maximize net present value at the DSU level.”

The operator kept watching costs relative to productivity. “Come 2017 and ’18, we trialed some plug-and-perf as we saw the cost of plug-and-perf dropping dramatically. We were able to get onto that learning curve and start the move to plug-and-perf at a cost point that made it incrementally more valuable to us,” he said.

“And this approach is what is driving our significant growth outlook in the Bakken. It’s simple, really: Lower-cost operations, combined with plug-and-perf, provide more entry points, more sand, which adds up to more efficient production.

“We expect to see 15% to 20% uplift on cumulative production over [wells’ first] 180 days and 5% to 10% uplift in EUR. That generates about $1 billion in net present value for us over our remaining inventory at a $60 [oil] price.
“That’s why we’re moving to plug-and-perf and that’s why we’re moving now as opposed to earlier.”

While Hess is transitioning to PP, Biggs said, “our overall goal remains maximizing net present value at the DSU level. This is what is driving the strong production outlook for Hess in the Bakken and one we expect to deliver approximately 200,000 boe/d [from Bakken operations] by 2021.”

Transition to optimization

Original fracture-stimulated horizontals in the middle Bakken, beginning in Montana in 2000, were openhole; the fractures were created wherever there was the least resistance. As the play was brought to North Dakota, operators, including Continental Resources, began using SS to create fractures within intervals along the length of the lateral, rather than the job all going to a few areas.

In 2010, Continental began to transition to PP. Nichols said, “We saw where it was a more efficient way for us to complete the wells. We thought we were getting better completion and there was some operational flexibility we didn’t have with the sleeves. We’ve been pretty much all plug-and-perf since 2010.”

Through 2013, jobs were generally with crosslinked fluid and relatively less proppant. Stages were between 30 and 40 per well with about 3 million pounds of proppant. An infill project in 2013, though, suggested “we weren’t effectively draining the reservoir,” Nichols said.

Continental started testing slickwater and, in 2014, it was doing a lot of different things. “We basically set up a matrix of different completion parameters we wanted to test in different areas,” Nichols said.

Pretty much everything was on the table. Among the variables: proppant volumes, proppant types, stage-interval perforation schemes. “I don’t know if we could say we had a ’standard [job]’ in 2014. But the average would come out to be about 5.5 million pounds of proppant per well and still around that 30-stage type of completion.”

With the data, the Continental team tailored completions to what was working in different areas, transitioning from “enhanced completion” to more of an “optimized” one.

“Right now, we’re looking at perf-cluster-spacing and volume per perf-cluster,” Nichols said. “We look at that perf-cluster as a point of contact as to how we drain the reservoir. So the question becomes, ’How do we efficiently drain the reservoir at that point? How many points do we need? And how do we efficiently deliver proppant to those points?’

“We’re starting to transition to where we’re treating slightly larger intervals, but we’re more efficiently treating within that interval.”

How many entry points per thousand feet? Typically, 30 to 50. “Fifty, we’re testing; we haven’t done a lot of it,” Nichols said. “Thirty is pretty common now. So we’re setting those clusters every 20 to 30 feet, basically, within the wellbore.”

The denser molecule

In Oasis’ Wild Basin Field in McKenzie County, the operator brought 10 wells online in its Rolfson North DSU in August and September of 2016 about 7 miles north of Watford City, the county seat, and about an hour’s drive west of both Mandaree and New Town.

Combined, the wells have produced some 3 MMbbl of oil through this past January. In particular, Rolfson North 5198 14-17 11BX made more than 194,000 bbl in its first 178 days online; production through this past January was 443,013 bbl.

The science-ing on where within the middle Bakken to land a lateral is brief—the zone is only about 30 to 60 feet thick. But Oasis’ Reid said that drilling improvements have nevertheless helped contribute to growth in overall North Dakota output: Drill days for a 10,000-lateral-foot hole have decreased from about 24 to 12 for Oasis. It’s less costly.

The best crews and best equipment working at both making the hole and completing it “just made the whole play super-efficient. If you look at statistics around production per rig, the Bakken is really one of the best plays.”

The concern about a slickwater completion back in the earliest days of the play was that—while it worked in the Barnett, a gas play—Bakken production is about 90% oil, a much denser molecule. And fracture-stimulation jobs involved less proppant concentration at the time.

“Right now, we’re looking at perf-cluster-spacing and volume per perf-cluster,” Nichols said. “We look at that perf-cluster as a point of contact as to how we drain the reservoir. So the question becomes, ’How do we efficiently drain the reservoir at that point? How many points do we need? And how do we efficiently deliver proppant to those points?’

“We’re starting to transition to where we’re treating slightly larger intervals, but we’re more efficiently treating within that interval.”

How many entry points per thousand feet? Typically, 30 to 50. “Fifty, we’re testing; we haven’t done a lot of it,” Nichols said. “Thirty is pretty common now. So we’re setting those clusters every 20 to 30 feet, basically, within the wellbore.”

The science-ing on where within the middle Bakken to land a lateral is brief—the zone is only about 30 to 60 feet thick. But Oasis’ Reid said that drilling improvements have nevertheless helped contribute to growth in overall North Dakota output: Drill days for a 10,000-lateral-foot hole have decreased from about 24 to 12 for Oasis. It’s less costly.

The best crews and best equipment working at both making the hole and completing it “just made the whole play super-efficient. If you look at statistics around production per rig, the Bakken is really one of the best plays.”

The concern about a slickwater completion back in the earliest days of the play was that—while it worked in the Barnett, a gas play—Bakken production is about 90% oil, a much denser molecule. And fracture-stimulation jobs involved less proppant concentration at the time.

Feature North Dakota DSUs

These DSUs are among those that have produced extraordinary wells, including one well that has made more than 140,000 barrels of oil in its first 73 days online, according to North Dakota Department of Mineral Resources records.
As a result, when first entering oil plays, operators switched to the more viscous cross-linked fluid that could deliver more proppant. By 2014, most of Oasis’ jobs were crosslink, with 30/50 and 20/40 ceramic proppant and a little bit of 100-mesh—about 4 million pounds of it. Stages averaged 36 for Oasis and it tested some of up to 50, pumping about 30 to 35 bbl per minute.

Since 2014, though, all Oasis jobs are slickwater. Pumping is 200,000 to 300,000 bbl vs. 60,000 bbl of crosslink. The rate is between 70 and 90 bbl per minute. The proppant is mostly 100-mesh sand—about 10 million pounds of it.

Stages today are as many as 70, but most operators are doing around 50. “And then there are clusters,” which came about over time and is “kind of a new advent.” Cluster spacing is about 25 feet now vs. 50 and 75.

“In each of those stages, the spacing between groups of perforations is getting closer together,” said Reid. “So we’ve gone from four to eight clusters in each stage. The entry points are now more dispersed along the lateral.

“There aren’t always necessarily more actual perforations—because we’re using limited-entry techniques. But they’re closer together, so there are more places along the lateral that you have entry points now than we used to have.”

**Fine-tuning**

Hunkering down in core leasehold has helped reduce cost, Reid said, “instead of moving [equipment and people] around to all these different areas. We moved into Wild Basin and have been drilling in Wild Basin four years. So we’ve had the same crews, the same rigs and all the infrastructure to support it.”

The big slickwater jobs mean moving more water—300,000 bbl per well—to the pad. “And then you need to dispose of it cheaply. It was a bit challenging” when operations were spread across the basin, he said.

But, “when you concentrate your activity and plan effectively, you’re able to pipe all that water in at a low cost and then pipe it all out into disposal wells without it ever going into trucks.”

The modern Oasis 10,000-footer is expected to cost less than $8 million. In 2013, a completed hole cost about $10 million and it was a smaller-intensity job. EUR today is between 30% and 50% greater.

Oasis finished 2018 with Williston Basin production of some 78,200 barrels of oil equivalent per day (boe/d), up 18% from 2017. Hess’ fourth-quarter 2018 Bakken production was 126,000 boe/d, up from 110,000 a year earlier. It expects 2019 Bakken production to average between 135,000 and 145,000 boe/d.

Continental’s fourth-quarter 2018 North Dakota Bakken production was 177,358 boe/d, up from 158,640 boe/d in fourth-quarter 2017.

Hess’ Biggs said, “We still have a 15-year inventory out there that can generate returns in excess of 50% at $60 WTI.” The operator continues to fine-tune what works best in any given area. “There’s no ‘one size fits all,’” Biggs said.

A standard completion is roughly 10 million pounds of proppant, Biggs said, “but we’re experimenting with wells that have 16 million pounds and some that have less [than 10 million] and experimenting with spacing and number of stages.

“Over the years, we’ve learned a lot, but we’re not done yet. There’s a lot more optimization that can come here with the hope that we can bring the economics up and extend that inventory to more acreage that sits outside the core of the core.”

Continental’s Nichols said there are some units in Continental’s leasehold where the geology changes pretty rapidly. But, “for the most part, when a design change works in one place, it tends to work to some degree in another.”

The company’s average first-year production per well from 2013 to 2018 has roughly tripled and, it added, “we’re still in early innings of developing our inventory.”

And the early-days wells—might these be recompleted in the future with modern jobs? Hess’ Biggs said, “Absolutely. We’ve seen others doing this in the basin. We’re going to save that in our inventory. We’re going to get a greater return on a new well [at this time]. We probably will not start to do a refrack program for probably another year or two.”

Continental’s Nichols said, “There are some options there [with refracks]. We’re focused on new-drills right now; it’s the best spend on our capital.

“But we’re keeping an eye on recompletions. As technology evolves, there’s always the possibility we can go back and develop those [old] wells further.”

---

**Production Data For Rolfson North 5198 14-17 11BX**

<table>
<thead>
<tr>
<th>Date</th>
<th>Days</th>
<th>Bbl Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-19</td>
<td>31</td>
<td>4,684</td>
</tr>
<tr>
<td>Dec-18</td>
<td>31</td>
<td>5,194</td>
</tr>
<tr>
<td>Nov-18</td>
<td>30</td>
<td>5,016</td>
</tr>
<tr>
<td>Oct-18</td>
<td>31</td>
<td>5,125</td>
</tr>
<tr>
<td>Sep-18</td>
<td>30</td>
<td>5,613</td>
</tr>
<tr>
<td>Aug-18</td>
<td>31</td>
<td>6,176</td>
</tr>
<tr>
<td>Jul-18</td>
<td>31</td>
<td>6,287</td>
</tr>
<tr>
<td>Jun-18</td>
<td>30</td>
<td>7,025</td>
</tr>
<tr>
<td>May-18</td>
<td>31</td>
<td>8,133</td>
</tr>
<tr>
<td>Apr-18</td>
<td>30</td>
<td>8,527</td>
</tr>
<tr>
<td>Mar-18</td>
<td>31</td>
<td>8,827</td>
</tr>
<tr>
<td>Feb-18</td>
<td>28</td>
<td>8,550</td>
</tr>
<tr>
<td>Jan-18</td>
<td>31</td>
<td>9,984</td>
</tr>
<tr>
<td>Dec-17</td>
<td>31</td>
<td>10,668</td>
</tr>
<tr>
<td>Nov-17</td>
<td>30</td>
<td>11,547</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Days</th>
<th>Bbl Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct-17</td>
<td>31</td>
<td>14,259</td>
</tr>
<tr>
<td>Sep-17</td>
<td>30</td>
<td>14,306</td>
</tr>
<tr>
<td>Aug-17</td>
<td>24</td>
<td>10,112</td>
</tr>
<tr>
<td>Jul-17</td>
<td>31</td>
<td>14,043</td>
</tr>
<tr>
<td>Jun-17</td>
<td>30</td>
<td>16,582</td>
</tr>
<tr>
<td>May-17</td>
<td>31</td>
<td>18,351</td>
</tr>
<tr>
<td>Apr-17</td>
<td>30</td>
<td>22,387</td>
</tr>
<tr>
<td>Mar-17</td>
<td>31</td>
<td>27,336</td>
</tr>
<tr>
<td>Feb-17</td>
<td>28</td>
<td>31,407</td>
</tr>
<tr>
<td>Jan-17</td>
<td>31</td>
<td>25,925</td>
</tr>
<tr>
<td>Dec-16</td>
<td>31</td>
<td>29,274</td>
</tr>
<tr>
<td>Nov-16</td>
<td>30</td>
<td>40,500</td>
</tr>
<tr>
<td>Oct-16</td>
<td>31</td>
<td>37,219</td>
</tr>
<tr>
<td>Sep-16</td>
<td>27</td>
<td>29,897</td>
</tr>
</tbody>
</table>

*Source: North Dakota Department of Mineral Resources*