

# Should the Industry P&A modern Bakken wells?

September 21<sup>st</sup>

North Dakota Petroleum Council 2022 Annual Meeting

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# **Liberty Resources Background**

- Liberty Resources team has been working the Bakken since 2009
- Liberty Resources 1: 2010 to 2013; ~43,000 net acres in Central Basin in NW McKenzie and S. Williams Counties, ~6,000 boepd.
- Founded Liberty Oilfield Services (now Liberty Energy NYSE: LBRT) in 2011
- Liberty Resources II founded in 2014:
  - ~80,000 net acres based on in NE Williams, NW Mountrail, SW Burke Counties
  - Operate 112 pdp wells (50/50 legacy and LR drilled)
  - Grew production to ~13,000 boepd in 2019; dropped to ~5,000 boepd at EOY '21
  - May '22 started running a continuous one-rig program; now producing ~9,000 boepd
- Liberty Midstream Solutions founded in 2018:
  - Built and operate 30 MMCF/D gas processing facility & associated gathering
  - 45 MBBL/D produced water disposal capacity and >90 miles of pipeline infrastructure



# Liberty Resources: Applying Technology to the Bakken

- Liberty has been a technology innovator in the Bakken:
  - First Slickwater new well completion in 2009 (SPE 163827)
  - Leader in Data Analytics / Multi-Variate Analysis for Completions Optimization (SPE 166479) leading to higher "frac intensity": more well length, more frac stages, more proppant, higher rate treatments.
  - Leader in high-rate artificial lift for high water cuts areas (>70% WC) using jet pumps (SPE 170916)
  - Working with EERC have run the first two Bakken pilots using on-site gas for Miscible EOR tests. (SPE 201471, URTeC-2019-961 & URTeC 2022-3722974).
- Advances in the last few years:
  - Drilling 3-mile laterals
  - Anti-collision drilling plans
  - Optimization of completions stage count and proppant loading
  - Geoengineered stage intervals and pump schedules
  - eXtreme Limited Entry (XLE) perforating: perf clusters to single point entry
  - Extensive use of HVFR fluids (High Viscosity Friction Reducer)
  - Continued on the leading edge of safety and environmental advances



# How Long Should a Bakken Well Produce?

#### Number of modern (post-2008 completion) Bakken wells P&A'd per year



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# Modern Bakken P&A Well Locator Maps







#### **By Operator**



### Modern Bakken P&A Wells by Year and Operator





# **Reasons for P&A**





## **P&A Statistics by Type and Formation**





### **Characteristics of Mechanical Failure P&A's**





# **Types of Mechanical Failure**





## **Characteristics of High Water Cut P&A's**





### **Characteristics of Low Productivity P&A's**





# Low Productivity P&A Well Type & Spacing





### Low Productivity P&A Well Spacing





## **Example 11 well Tightly Spaced Development Project**



RESOURCES

# **Completion Type of Low Productivity P&A's**





## What Completion Issues Could the Industry Be Facing?

- Degradation of the frac "effectiveness" with time
- Our productivity of our frac networks are a function of both the extent of the Stimulated Reservoir Volume (SRV) and the fracture conductivity – especially in its connection back to the wellbore





#### **CONDUCTIVITY PROJECTIONS FROM 8-MONTHS OF TESTING AT BAKKEN CONDITIONS**



**Figure 9:** Conductivity projected for  $1 \text{ lb}_m/ft^2$  proppant concentrations at 7,500 psi.

| TIME  | LWC 40/70 mesh | WS 40/70 mesh | BS 40/70 mesh | BS 100 Mesh  |
|-------|----------------|---------------|---------------|--------------|
|       | Conductivity   | Conductivity  | Conductivity  | Conductivity |
| Years | md-ft          | md-ft         | md-ft         | md-ft        |
| 0     | 600            | 106           | 63            | 17           |
| 0.5   | 374            | 31            | 19            | 7            |
| 1     | 356            | 25            | 16            | 6            |
| 1.5   | 345            | 22            | 14            | 5            |
| 2     | 337            | 19            | 12            | 5            |
| 3     | 326            | 15            | 10            | 4            |
| 5     | 312            | 11            | 7             | 4            |
| 10    | 294            | 5             | 4             | 3            |
| 15    | 283            | 1             | 2             | 2            |
| 20    | 275            | 0             | 0.2           | 2            |
| 30    | 264            | 0             | 0             | 1            |
| 40    | 256            | 0             | 0             | 1            |

**Table 6:** Predicted Conductivity for 1lb<sub>m</sub>/ft<sup>2</sup> LWC and SandProppants over 40 years at 7,500 psi

#### SPE International Hydraulic Fracturing Technology Conference and Exhibition Muscat, Sultanate of Oman

#### Bakken Simulation Results Using Conductivity Decline in ResFrac 3D Simulator (History Matched on Martin -3MBH well, Twp. 158N, 93W)



*Figure 9:* 30-Year Cumulative Oil Plots for the Various Bakken Fracture Designs

| Proppant Design                  | Productive Life | Cumulative Oil<br>Recovery (STB) | Oil Recovery Relative<br>to "All Ceramic" Design |         |  |  |  |  |
|----------------------------------|-----------------|----------------------------------|--|---------|--|--|--|--|
|                                  | (Tears)         |                                  | (%)  | (STB)   |  |  |  |  |
| 40/70 White Sand                 | ~16             | 269,702                          | 77%  | -78,650 |  |  |  |  |
| 40/70 Brown Sand                 | ~16             | 260,732                          | 75%  | -87,620 |  |  |  |  |
| 40/70 LW Ceramic                 | >30             | 348,352                          | <u> </u>   | -       |  |  |  |  |
| 40/70 LW Ceramic 10% Lead & Tail | >30             | 337,058                          | 97%  | -11,294 |  |  |  |  |

**Table 5:** 30-Year Calculated Cumulative Oil Recovery for theMiddle Bakken Fracture Designs

## When Is Industry Required to P&A Modern Wells?

#### NDIC Century Code 43-02-03-55

43-42-03-55. ABANDONMENT OF WELLS, TREATING PLANTS, OR SALTWATER HANDLING FACILITIES - SUSPENSION OF DRILLING.

- 1. The removal of production equipment or the failure to produce oil or gas, or the removal of production equipment or the failure to produce water from a source well, for one year constitutes abandonment of the well. The removal of injection equipment or the failure to use an injection well for one year constitutes abandonment of the well, The failure to plug a stratigraphic test hole within one year of reaching total depth constitutes abandonment of the well. The removal of treating plant equipment or the failure to use a treating plant for one year constitutes abandonment of the treating plant. The removal of saltwater handling facility equipment or the failure to use a saltwater handling facility for one year constitutes abandonment of the saltwater handling facility. An abandoned well must be plueged and its site must be reclaimed, an ahandoned treating plant must be removed and its site must be reelaimed, and an abandoned saltwater handling facility must be removed and its site must be reclaimed, pursuant to sections 43-02-03-34 and 43-02-03-34.1. A well not producing oil or natural gas in paying quantities for one year may be placed in abandoned-well status pursuant to subsection 1 of North Dakota Century Code section 38-08-04. If an injection well is inactive for extended periods of time, the commission may, after notice and hearing, require the injection well to be plugged and abandoned.
- 2. The director may waive for one year the requirement to plug and reclaim an abandoned well by giving the well temporarily abandoned status for good cause. This status may only be given to wells that are to be used for purposes related to the production of oil and gas within the next seven years. If a well is given temporarily abandoned status, the well's performance must be isolated, the integrity of its casing must be proven, and its casing must be scaled at the surface, all in a manner approved by the director. The director may extend a well's temporarily abandoned status and each extension may be approved for up to one year. A fee of one hundred dollars shall be submitted for each application to extend the temporary abandonment status of any well. A surface owner may request a review of a well temporarily abandoned for at least seven years pursuant to subsection 1 of North Dakota Century Code section 38-08-04.
- 3. In addition to the wniver in subsection 2, the director may also waive the duty to plug and reclaim an abandoned well for any other good cause found by the director. If the director exercises this discretion, the director shall set a date or circumstance upon which the waiver expires.

#### AB Status

- Failure to produce oil or gas for 1 year
- Failure to use an injection well for 1 year
- An abandoned well <u>must</u> be plugged and its site must be reclaimed

#### TA Status

- Director <u>may</u> waive for 1 year the requirement to plug and reclaim abandoned well by giving the well TA status <u>for good</u> <u>cause</u>
- Status <u>may</u> only be given to wells that are to be used for purposes related to the production of oil and gas within the next 7 years



## Summary

- 146 modern P&A'd wells in twelve years is a wasted resource of over \$1 Billion invested
- Low Productivity P&A's constitute nearly half of all modern well P&A's (63 wells) ~\$500 Million of invested capital; and are a growing percentage of all P&A's
- Yet these wells have only produced primary reserves

# Should the Industry P&A modern Bakken wells?

- Low Productivity wells offer an opportunity for recompletions, and secondary & tertiary recovery
- Industry and the State need to work together to prevent the current P&A wastage that is occurring by:
  - modifying the Century Code (or its interpretation) to allow a greater time period before a modern Bakken well needs to be P&A'd
  - working to implement secondary or tertiary recovery techniques for low productivity wells especially on pads with tightly spaced wells
- Industry needs to change focus to look at medium and longer term recovery and value generation • our completion optimization is focused too much on short-term performance metrics (minimized capital spend, 180-day or 365-day cumulative oil recovery)

# Thank you

# **Questions**?

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