Boom, Bust, and Frac: Coping With the Downturn

“Hydraulic Fracturing to Survive in 2016”

C. Mark Pearson
Liberty Resources LLC
Why are we still Fracking?

- To HBP acreage
- Support Cash Flow
- Maintain Borrowing Base
- “The Boss Told Me To”

Should we be designing the Horizontal Well Completion to maximize initial rates/cash flow, maximizing reserve recovery, or minimizing completion spend?
Williston Central Basin (Twp 148-159N, R97-105W) - 1330 Bakken Wells (completions since 1/15/2009, production through Aug 2013)
Bakken Tier 1 Case Study: South Williams County

Twp 153 & 154N; R 99W
Company A Completion (the “Liberty” Slickwater Design):
- 35 Stages
- Plug and Perf
- Slickwater
- 3.7 Million lb proppant
  (100% ceramic)

Company B Typical Completion:
- 30 Stages
- Plug and Perf
- X-Linked Gel
- 2.6 Million lb proppant
  (30% ceramic; 70% sand)
Bakken Tier 1 Case Study: 90-day Cum Oil

Average 62,094 bbl

Average 40,435 bbl
Bakken Tier 1 Case Study: November 2012 Update

- 950 MBOE
- 700 MBOE
- 450 MBOE
Bakken Tier 1 Case Study: Two-Year Cum Oil Update

Average 248,517 bbl

Average 154,849 bbl
Bakken Tier 1 Case Study: Nov. 2015 Update

Cumulative Oil Production, Bbls

- 950 MBOE
- 700 MBOE
- 450 MBOE

Producing Days

Operator A (6 wells)
Operator B (7 wells)
950 MBOE Type Curve
700 MBOE Type Curve
450 MBOE Type Curve

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Bakken Tier 1 Case Study: Nov. 2015 Update

10 MM$ D&C
91% IRR

9 MM$ D&C
56% IRR

$95 WTI
Bakken Tier 1 Case Study: Nov. 2015 Update

450 MBOE
700 MBOE
950 MBOE
10 MM$ D&C
91% IRR
7 MM$ D&C
56% IRR
$95 WTI
7.5 MM$ D&C
7% IRR
7 MM$ D&C
1% IRR
$40 WTI

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Bakken Tier 2 Case Study: NW McKenzie County

Twp 151-152N; R: 102-104W
Bakken Tier 2 Case Study: NW McKenzie County
Bakken Tier 2 Case Study: 90-day Cum Oil Bubble Plot
## Bakken Tier 2 Case Study: April 2013 Update

### Table: Injection Fluids and Parametric Values

<table>
<thead>
<tr>
<th>Operator</th>
<th>Well #</th>
<th>Fluid</th>
<th>MMBls Prop</th>
<th>#Stages</th>
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<tbody>
<tr>
<td>A</td>
<td>WA-1</td>
<td>P+n-P</td>
<td>4.1</td>
<td>35</td>
</tr>
<tr>
<td>A</td>
<td>WA-2</td>
<td>P+n-P</td>
<td>4.2</td>
<td>35</td>
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<tr>
<td>B</td>
<td>WB-1</td>
<td>P+n-P</td>
<td>3.7</td>
<td>35</td>
</tr>
<tr>
<td>B</td>
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<tr>
<td>C</td>
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<tr>
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<td>SS</td>
<td>1.6</td>
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</tr>
</tbody>
</table>

### Graph: Cumulative Oil Production

- **600 MBOE**
- **400 MBOE**
- **250 MBOE**

- **Operator A (2 wells)**
- **Operator B (2 wells)**
- **Operator C (1 well)**
- **Operator D (2 wells)**
Bakken Tier 2 Case Study: Nov. 2015 Update

600 MBOE
400 MBOE
250 MBOE
Bakken Tier 2 Case Study: Nov. 2015 Update
with added wells (SE of T152N-R103W & NE of T151N-R103W)
Bakken Tier 2 Case Study: Nov. 2015 Update
with added wells (SE of T152N-R103W & NE of T151N-R103W)

$95 WTI
10 MM$ D&C
30% IRR
9 MM$ D&C
13% IRR
8 MM$ D&C
3% IRR

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Bakken Tier 2 Case Study: Nov. 2015 Update
with added wells (SE of T152N-R103W & NE of T151N-R103W)

Higher early-time production rates result in higher multi-year cumulative recoveries, and higher EURs.

Lower early-time production rates result in lower multi-year cumulative recoveries, and lower EURs.

$50 WTI
- 7.5 MM$ D&C
  4% IRR
- 7 MM$ D&C
  -4% IRR
- 6.5 MM$ D&C
  -13% IRR
Bakken Historical Completions
Number of Frac Stages/Well

The graph shows the number of frac stages per well over time, with data points for North Dakota MB Wells (6518 Wells) and average frac stages. The x-axis represents the date from January 1, 2008, to December 31, 2015, while the y-axis represents the number of stages per well from 0 to 100.
Stage Count / Interval Length

• More Stages ➔ More Production / Recovery
  - Change the Pumping Contract from “per stage” to “per increment of pumping time”
  - Reduce the # of stages, but pump larger volumes to maintain designed proppant lb/ft or volume bbl/ft
  - Re-design with fewer stages but having more perforation clusters – go from a “stage design” to a “cluster design”.
Frac Design per the IR Analysts? …..
William “FracPup” Pearson
Be Careful Using Linear Correlations
SPE 179171 – E. Lolon et al; to be presented on Thursday Morning!!

Middle Bakken: T148-159N, R97-105W

180-Day Cumulative Oil/ft Lateral, BO/ft

Proppant Mass, Lb/ft

- Multiple Regression Model 1
- Multiple Regression Model 2
- BIC Chosen Model
- AIC Chosen Model
- Random Forests
- GBM

- Base case
- 2*Stand.Dev.
Summary

• The Horizontal Well Completion is Critical to Long-Term Recovery
• The fracs you design today will define the well’s recovery over the next 30 – 40 years
• Beware of making cuts in the completion spend thinking it is just affecting initial production rates and early-time cumulative production
• Use the slowdown in industry activity to do a better job engineering the completion and not just using a geometric design.
• Work on “GeoEngineering” your completion
Liberty Resources’ “Fracking to Survive in 2016”

- Frac wells as needed to HBP acreage or maintain financial covenants

- Changed design to reduce costs:
  - Larger job sizes rather than more frac stages
  - Pumping higher proppant concentrations to cut fluid volumes ~10%
  - Changing from premium proppants to sand
  - Reducing the chemical additive packages to what has been proven to be needed

- Changed design to improve performance:
  - More proppant volume per lateral foot
  - More perforation clusters having less individual perforations
  - Use of diversion material during the stages

- GeoEngineering the completion
Acknowledgements

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THANK YOU