North Dakota Oil & Gas Research Program

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Director
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May 22, 2017
March 2017 – Bakken Economics Updated
Slides Available Online
North Dakota Drilling Activity

[Graph showing the number of drilling rigs and spuds from December 2009 to April 2017. The graph includes three lines: one for spuds, one for drilling rigs, and one for spuds per rig per month. The y-axis represents the number of units, ranging from 0 to 300, while the x-axis represents the months from December 2009 to April 2017.]
DUC’s* - Proximity to High Performing Wells

Buffer Zone
- 1250
- 800

Max. Buffer
- <800
- 800
- 1250

*Non-Confidential Only
DUC’s* - Proximity to High Performing Wells

Max. Buffer

- <800
- 800
- 1250

*Non-Confidential Only
North Dakota Oil Differential

Based on EIA Data

North Dakota-WTI Differential
North Dakota-Brent Differential

Based on EIA Data
NDPA ND Oil Production Forecast

North Dakota Oil Production, BOPD

- ND Oil Case 1
- ND Oil Case 2

2014 - 2020
North Dakota Oil Production Forecast

Production forecast is for visual demonstration purposes only and should not be considered accurate for any near or long term planning.
North Dakota Forecast Activity Assumptions

The graph illustrates the forecasted number of new wells added per month in North Dakota, with two case scenarios:

- **Red Line**: ND New Wells Case 1
- **Gray Line**: ND New Wells Case 2

The forecast is divided into two parts:

1. **2009-2017**: Historical data showing fluctuations in new well additions.
2. **2017 onwards**: Predicted forecast for new well additions with Case 1 and Case 2 scenarios.

The NDPA (North Dakota Pipeline Authority) forecast is indicated for comparison.
US Williston Basin Oil Production - 2017

<table>
<thead>
<tr>
<th>MONTH</th>
<th>ND</th>
<th>Eastern MT*</th>
<th>SD</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>981,380</td>
<td>52,239</td>
<td>3,553</td>
<td>1,037,172</td>
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<tr>
<td>February</td>
<td>1,034,248</td>
<td>53,448</td>
<td>3,718</td>
<td>1,091,414</td>
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<td>March</td>
<td>1,025,638</td>
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<td>April</td>
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<tr>
<td>December</td>
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</tbody>
</table>
Estimated Williston Basin Oil Transportation

- Pipeline Export: 58%
- Refined: 8%
- Truck to Canadian Pipelines: 7%
- Estimated Rail: 27%

March 2017
Estimated Williston Basin Oil Transportation

- Estimated Rail
- Estimated Pipeline Export
- Refined
- Truck to Canadian Pipelines
- Brent - WTI Spread (EIA)

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Estimated ND Rail Export Volumes
Rail Destinations Market Share (Feb. 2017)

Destination Market Share
- Canada
- PADD I (East Coast)
- PADD II (Midwest)
- PADD III (Gulf Coast)
- PADD IV (Rockies)
- PADD V (West Coast)

Data for Rail Destination Market Share Provided by the US Energy Information Administration
Major Rail Lines and Refineries

EIA February 2017 Refiner Acquisition Cost

- PADD V: $53.31
- PADD IV: $44.81
- PADD II: $49.59
- PADD I: $53.29
- PADD III: $51.37
Pricing Data: Bloomberg & CME (LLS-Argus)

Cushing $50.73

Brent $53.97
WTI + $3.24

LLS (Argus)
WTI + $2.12
Williston Basin Truck Imports and Exports with Canada

Data for truck imports/exports chart is provided by the US International Trade Commission

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Solving the Flaring Challenge

Total ND Gas Flaring Percent (Color Indicates Reason)

- Flaring % From Wells Connected to Sales
- Flaring % From Wells Not Connected to Sales
- Total ND Gas Production

ND Gas Production, MMCFD

May-14 to Mar-17
Solving the Flaring Challenge

- New Wells Selling Gas
- New Producing Wells

Number of Wells Per Month

3/1/2005 to 3/1/2017
Plant Natural Gas Liquids - (Feb 2017)

- All NGLs, BPD
- Ethane, BPD
- Propane, BPD
- Butane, BPD
- Natural Gasoline, BPD

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North Dakota Captured* NGL’s

*Non-flared NGL’s & Assumes 10 GPM
Major NGL Pipeline and Processing Infrastructure
NGL Capacity Is Complicated…

Barrels Per Day

- Northern Border (70 mbpd)
- Aux Sable Prairie Rose
- Alliance Tioga Lateral
- WBI Transmission
- ONEOK Bakken NGL
- Purity Truck/Rail & Rail
- Vantage
- Additional Northern Border
- Case 1: All Captured NGLs
- Case 2: All Captured NGLs
Construction Update
North Dakota Pipeline Construction

- New Miles
- Year End Miles

<table>
<thead>
<tr>
<th>Year</th>
<th>New Miles of Pipe</th>
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<tbody>
<tr>
<td>2008</td>
<td>673</td>
</tr>
<tr>
<td>2009</td>
<td>1,355</td>
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<tr>
<td>2010</td>
<td>1,010</td>
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<tr>
<td>2011</td>
<td>2,353</td>
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<td>2012</td>
<td>3,184</td>
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<tr>
<td>2013</td>
<td>2,828</td>
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<tr>
<td>2014</td>
<td>2,179</td>
</tr>
<tr>
<td>2015</td>
<td>2,178</td>
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</tbody>
</table>

Total Miles of Pipe: 25,439

Sources: NDIC & PHMSA

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Bakken Refracs
Refracs In the Bakken*

*While careful work was performed to discover as many non-confidential, modern refracs as possible, this data set is likely not all inclusive.
Spud Year of Bakken Refrac Wells*

*While careful work was performed to discover as many non-confidential, modern refracs as possible, this data set is likely not all inclusive.
Performance Pre/Post Refrac

BOPD

Avg. BOPD

Max BOPD2

Production Month

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Performance Pre/Post Refrac

BOPD

Avg. BOPD

Max BOPD

Production Month
Performance Pre/Post Refrac

BOPD

Production Month

Avg. BOPD

Max BOPD2
Performance Pre/Post Refrac

BOPD

Avg. BOPD

Max BOPD2

Production Month
Performance Pre/Post Refrac
Performance Pre/Post Refrac
209,000 Barrels of Incremental Production

Incremental Production (Refrac)
Original Decline
Original Production
257,000 Barrels of Incremental Production

- Incremental Production (Refrac)
- Original Decline
- Original Production

Production Month

BOPD

0 100 200 300 400 500 600 700

1 9 17 25 33 41 49 57 65 73 81 89 97 105 113 121 129 137 145 153 161 169 177 185 193
253,000 Barrels of Incremental Production

Incremental Production (Refrac)
Original Decline
Original Production

Production Month
Refrac Candidates

- Refrac selection is based on a number of criteria, many of which are not available in the public domain.
- Refracs have been performed with success on a wide range of well ages and performance.
- Refracs are designed to address one or more reservoir level issues impacting well performance (e.g. scaling, embedment, proppant rearrangement, fines generation, etc).
- The following work is not intended to imply a well will be refraced, but rather that the wells fit a certain criteria that may make them a near term candidate for refrac.
Peak Month Minimum
200 BOPD

3,074 BKN Wells
Spud 2007-2011

Potential Near term
Refrac Candidates?
Proximity to High Performing Wells

- 2.5 Mile Historic Peak Month Buffer Zone
- 1,955 Wells Within the 800+ BOPD Buffer

Buffer Zone:
- 1250
- 800
Total Depth of Previously Refraced Wells

- 10,000’-14,999’
- 15,000’-19,999’
- 20,000’+

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Total Depth & Buffer Zone of the 1,955 Wells

- **Total Depth**
  - 10,000’-14,999’
  - 15,000’-19,999’
  - 20,000’+

**Buffer Zone**
- 1250
- 800

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Base Production Declines*

Refracs Have the Potential to Alter These Declines

*Non-Confidential Bakken/Three Forks Production Only
Next Steps

• How does ND’s production profile shift if/when horsepower is added or reallocated to refracs?

• How do the economics of a refrac compare to a new drill and completion?

• How does ND’s midstream industry react to meet shifting production volumes? (Locally & Regionally)
Contact Information

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