North Dakota

Development of Bakken Formation Resources

- Activity
- Frack Water
- Stage Fracking
- Three Forks
- Oil Quality
- Transportation

Bruce E. Hicks
Assistant Director
NDIC-DMR-OGD
Bismarck, ND
Current drilling activity is focused in Mountrail, Dunn, McKenzie, and Williams Counties.
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Current drilling activity is focused in northwestern North Dakota, with 83% in Mountrail, McKenzie, Dunn, and Williams Counties.

- Wil
- Mtl
- McK
- Dun

10,000 sq mi
5000 wells
1H/1280
North Dakota Industrial Commission Cases Heard

5-fold increase in case load
No increase in OGD staff
North Dakota New Well Permits Issued

2011 Activity level currently exceeding 2010 record year.
Currently 171 rigs—more rigs coming!

Consistently 95% Bakken.

171 rigs X 12 wells/rig/year = 2,052 wells per year
North Dakota Well Depth and % Horizontal

1987
North Dakota Wells Producing Each Year

5446 total wells – 1983 Bakken horizontal (36.4%)
Steep declines
65%-1st yr
35%-2nd yr
15%-3rd yr
10% thereafter
Production 360,000 bopd (appr 290,000 from Bakken—79.8%)
North Dakota Monthly Production Top 12 Counties

37% of State
United States Daily Oil Production -- October 2010

Data from US Energy Information Administration

#8 producer 3 years ago
Now #4, eyeing #2
Mechanically isolated fracture treatment stages provide for more effective stimulation of entire Bakken pay interval.
Run in hole with:
- 4.5” liner
- 30-40 swell packers
- sliding sleeves
- 4.5” frack string
TYPICAL HORIZONTAL OIL WELL

Potable Waters

4.5” Frack String

Cement

Packer

4.5” liner

Upper Bakken Shale
Middle Bakken
Lower Bakken Shale
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Performing hydraulic fracture stimulation south of Tioga
• all Bakken wells must be hydraulically fractured to produce
• > 2 million gallons of water
• > 3 million pounds of sand
• cost > $2 million
Thirsty Horizontal Wells

- 2,000 wells / year
- 15-25 years duration
- 20 million gallons water / day
FRAC WATER NEEDS

• Lake Sakakawea best water resource
  • one inch contains 10 billion gal water
  • 5000 wells @ 2mil gal wtr/well
• > 2-year supply
WHY FRACK THE ROCK?

• already developed easy oil
  • oil flows easily without fracking

• Unconventional Reserves
  • reservoirs are tight
  • uneconomic to produce w/o fracking
  • must create a path for oil to flow
Thousands of fractures are created
- pumping water at 6,000-9,000 psi
- millions of pounds of sand and ceramic beads are pumped with the water to hold the fractures open.

Ball and Sleeve
- up to 40 stages
- ball opens the liner sleeve
Stage Fracturing
- up to 40 stages
Purposes of frack fluid

- crack the reservoir
- gel strength to carry sand

Frack fluid is produced back as flowback
Each hydraulic fracturing stage creates hundreds of fractures extending several hundred feet from wellbore.
Three-Dimensional Geologic Model of the Parshall Area

NORTH DAKOTA GEOLOGICAL SURVEY
Sea Level
Oil & Gas
Bakken/Three Forks
Precambrian Basement
Base of fresh water
States have been regulating the full life cycle of hydraulic fracturing for decades

- Water Appropriation Regulation
- Oil & Gas Regulation
- Health Department Regulation
- Geologic setting in each basin different
Hydraulic Fracturing Stimulation is Safe

- IOGCC survey—no contamination
- GWPC study verifies State’s regs
- GWPC National Registry f/chemicals
  - FracFocus
BAKKEN FORMATION

Upper shale member

Middle member

Lower shale member

THREE FORKS FORMATION
NDIC-DMR estimated

- appr 200-300 billion bo in place in ND
- 34-yr supply @ current US consumption
  - 2.1 billion bo recovery in ND w/1well
  - 4.2 billion bo recovery in ND w/2wells
  - 1-7 horizontal wells / spacing unit

USGS estimated (independent simultaneous study)

- 2.6 billion bo recovery in ND
- largest continuous resource they have assessed in lower 48 States
2010 Three Forks Assessment
Call the NDGS to order
(701-328-8000)
THREE FORKS FORMATION

NDIC-DMR estimated

- 1.9 billion bo recovery in ND w/1well
- 3.8 billion bo recovery in ND w/2wells

USGS: (Study coming?)
BAKKEN POOL: BAKKEN AND THREE FORKS ASSESSMENT
EXPECTED ULTIMATE RECOVERY

Bakken Fm.  1.9 billion barrels
Three Forks Fm.  2.1 billion barrels

Total recovery = 4 billion barrels w/ 1 well / spacing unit
Total recovery = 8 billion barrels w/ 2 wells / spacing unit

(Nordeng and Helms, 2010)
Fig. 7) Combined OOIP for the Three Forks and Bakken by county.
ESTIMATED MATURE AREA OF THE BAKKEN FORMATION

(Nordeng, 2010)
Current drilling activity is focused in northwestern North Dakota. 83% in Mtl, McK, Dun, and Wil Counties.
<table>
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<th>File No.</th>
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Forecasting Williston Basin Oil Production, BOPD

Production forecast is for visual demonstration purposes only and should not be considered accurate for any near or long term planning.
Rail Transportation

EOG – Stanley, ND

Others Include:
Minot
Dore
Stampede
Donnybrook

Images Provided By:
Loren Kopseng

Dakota Transport Solutions – New Town, ND
Williston Basin Oil Production & Export Capacity, BOPD

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Several Exciting Developments For Post 2010 Crude Oil Transport

- Enbridge Bakken Expansion Program
- Keystone XL Marketlink
- True Co.’s Baker 300
- Plains Bakken North
- Unit Train Development
Bakken Pipeline Expansion

Enbridge Pipelines (North Dakota)

Bakken Pipeline Expansion Project: Berthold to Cromer

Phase 7 Beaver Lodge Looping Project: Beaver Lodge to Berthold

EPND Phase 7 Gathering Projects: SORTI, Dunn, Plaza and McGregor

Image Provided by Enbridge North Dakota
Proposed TransCanada Marketlink

- 65,000 bopd committed (100,000 bopd design)
- 2013 Startup (Subject to Presidential Permit)
**True Co.’s Proposed “Baker 300”**

- **Butte Pipeline Capacity**
  - Current: 118,000 BOPD
  - 2011: 150,000 BOPD
  - Q1 2012: 200,000 BOPD (w/Loop)

- **Keystone XL Interconnect**
  - Q1 2013: 100,000 BOPD
Plains Bakken North Pipeline

Proposed Capacity
50,000-75,000 BOPD
Q4 2012

New 103 Miles, 12” Pipeline
Reverse Wascana Pipeline

$160-$200 Million
**Williston Basin Oil Production & Export Capacity, BOPD**

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*Projects still in the proposed or internal review process*
Existing
1) Stampede
2) Donnybrook
3) Ross
4) Stanley – EOG
5) Minot – ND Port Services
6) Dore
7) New Town – Dakota Transport Solutions
8) Beulah

Planned
1) Trenton – Savage
2) Epping – Rangeland
3) Tioga – Hess
4) Dickinson - EDOG
Williston Basin Oil Production & Export Capacity, BOPD

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*Projects still in the proposed or internal review process
NDPA Monthly Webinars

- Past Slides and Video Available Online
- Industry Experts
- New Topics Each Month
- Audience Interaction
Greetings

Season’s Greetings from the North Dakota Pipeline Authority! While the temperature in North Dakota is dropping fast, the activity in North Dakota’s oilfields is heating up. With more rigs moving into the basin, improved well completion techniques, and quicker spud to spud times, North Dakota petroleum production is expected to grow for many years to come. Along with the growing crude oil production, several exciting transportation expansion projects are very near completion, with many more in the works. For additional project information, past newsletters, maps, reports, and more please visit the Pipeline Authority Website, www.pipeline.nd.gov.

Enbridge Phase VI Expansion Update

The much anticipated Enbridge Phase VI Expansion is nearly complete. Scheduled to be in service on January 1, 2010, the expansion will increase Enbridge’s mainline capacity to Clearbrook, MN from 110,000 bbls per day (BOPD) to 161,600 BOPD. Once complete, Enbridge North Dakota will have more than doubled its 2007 system capacity of 80,000 BOPD.

More good news is that Enbridge has no intentions of stopping at 161,600 BOPD and is actively working to gain support from interested shippers for the proposed Portal Reversal Expansion Project or PREP. As proposed, PREP would allow Enbridge to transport an additional 30,000 BOPO by 2011 and up to an additional 115,000 BOPD by 2013.

Statistics

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<th>Aug-09</th>
<th>Sept-09</th>
<th>Oct-09</th>
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</thead>
<tbody>
<tr>
<td>Average Daily Oil Production, BOPD</td>
<td>232,355</td>
<td>238,265</td>
<td>239,067</td>
</tr>
<tr>
<td>Average Daily Gas Production, MMCFD</td>
<td>266.66</td>
<td>259.76</td>
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<td>Wells Producing</td>
<td>4,545</td>
<td>4,579</td>
<td>4,606</td>
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<tr>
<td>Average Rig Count</td>
<td>45</td>
<td>51</td>
<td>56</td>
</tr>
</tbody>
</table>

As of December 18, 2009, there are 77 active rigs in North Dakota.

Prairie Rose Pipeline Nears Completion

An unexpected construction specification change has delayed the startup of the Pecan Prairie Rose Pipeline until Mid-January, 2010. The new 75 mile, 12 inch pipeline is designed to transport up to 80 million cubic feet of unprocessed natural gas per day from Mountair County to an interconnect with the Alliance Pipeline near Towner, ND.

Proposed Baker Storage Enhancement

Williston Basin Interstate Pipeline Company is developing a project to increase firm deliverability from its Baker gas storage field in eastern Montana. With current firm storage withdrawal rates of 115 million cubic feet per day (MMCFD), Williston Basin sees an opportunity to add an additional 125 MMCFD of firm withdrawal capacity, which would more than double the firm withdrawal rate from Baker. Along with the gas storage field upgrades, Williston Basin is planning a pipeline expansion to transport the increased, firm storage volumes to an interconnect with the Northern Border Pipeline in North Dakota. The project has a proposed in-service date of 2012 and an open season is expected in January 2010.

Natural Gas Storage Explained

During the mid 1990’s, natural gas grew in popularity as a winter heating fuel. As a result, natural gas markets began experiencing seasonal demand swings that needed be managed using underground storage operations. Depleted natural gas fields are most often targeted for storage due to existing infrastructure and reservoir knowledge. During the summer months when demand is low, natural gas is injected into storage and when demand increases in the winter months, natural gas is withdrawn for consumer use.

ND Pipeline Authority

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