Oil & Natural Gas: The Evolving Freight Transportation Impacts

Prepared for

Northwestern University Transportation Center

Northwestern University Transportation Center
Business Advisory Committee Meeting
October 31, 2012 Evanston, IL
About PLG Consulting

» Boutique consulting firm specializing in logistics, engineering, and supply chain
  ▪ Established in 2001
  ▪ Over 80 clients and 200 engagements
  ▪ Significant shale development practice since 2010

» Headquarters in Chicago USA, with team members throughout the US and with “on the ground” experience in:
  ▪ North America / Europe / South America / Asia / Middle East

» Consulting services
  ▪ Strategy & optimization
  ▪ Assessments & benchmarking
  ▪ Transportation assets & infrastructure
  ▪ Logistics operations
  ▪ M&A/investments/private equity

» Specializing in the logistics of
  ▪ Oil & gas
  ▪ Chemicals & plastics
  ▪ Wind energy & project cargo
  ▪ Bulk commodities (minerals, mining, agricultural)
  ▪ Industrial & consumer goods
Other recent energy “boom” events with major transportation impacts

» Common characteristics
  - New technology breakthroughs and/or dramatic market shifts
  - Speed to market is paramount
  - Rush of capital and new players
  - Continuous change and evolution in both technology and markets
  - Logistics and related infrastructure of greater importance in shale development, and therefore a major platform for competition and strategy
Hydraulic Fracturing

Hydraulic fracturing, or “fracking,” involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.

Source: NPR.org

Graphic by Al Granberg
Hydraulic Fracturing Equipment Staging Area

- Frac Tanks/Fluid Storage
- Chemical Trucks
- Blender
- Sand Storage Unit
- Pump Trucks
- Data Van

Source: JPTOnline.org
1,839 rigs in operation as of October 19, 2012
Rush of capital into the industry
700% increase in shale gas production since 2007
Domestic oil production at 14-year high (6MM bbl/d)
“Unconventional” becomes “conventional” by 2015

Figure 56. U.S. production of shale gas in four cases, 2000-2035 (trillion cubic feet)
Chemical Feedstocks

Natural Gas & Petrochemical Supply Chain

Refined Crude Products

Chemical Feedstocks

Petrochemical Processing

Olefins

Ethenylene  Propylene  Butylene

Petrochemicals

Aromatics  Ammonia  Many Others

Polymers

Polybutadiene  Polypropylene  Polyethylene

Manufacturing

Intermediates become consumer and industrial products

Power Generation

Natural Gas

Industrial Use

Consumer Use

Process

Product

Logistics Flow

Consumers
Benefits Go Beyond Energy

Shale development a “net win” for United States

- Highly advantaged NGL cost structure vs. rest of world (ethane vs. naphtha)
- Creates strong, long-term export market for US polyethylene and other petrochemicals
- Abundant natural gas benefits domestic manufacturing
  - Lower electricity prices
  - Lower feedstock costs
- Jobs creation
- Trade deficit reduction

Source: American Chemistry Council, EIA

Source: IHS
Hydraulic Fracturing Materials Inputs and Logistics – Per Well

- **Materials**
  - Proppants
  - OCTG (Pipe)
  - Chemicals
  - Clean Water/Cement

- **Sources and Transloading**
  - Local source
  - Total Railcars: 47
    - Proppants: 40
    - OCTG (Pipe): 5
    - Chemicals: 2
  - Waste Water: ~500 Total Truckloads

- **Transloading to Wellhead Site**
  - Total Railcars: ~1,200
    - Proppants: 160
    - OCTG (Pipe): 20
    - Chemicals: 8
  - Waste Water: ~500 Total Truckloads

- **Oil/Gas/NGLs**
  - Truck, Rail, Pipeline

- **Total**
  - Railcars: ~1,200
  - Truckloads: ~500
Correlation of Operating Rig Count with Sand and Crude Shipments

STCC 14413 (sand) and 13111 (petroleum)  Data sources: US Rail Desktop, Baker Hughes
All Sand Handled by Railroad

Class I Railroads of North America

Quarterly Data

Carloads

2008 2009 2010 2011 2012

STCC 14413 Source: US Rail Desktop
Sand Mining Continues to Expand

» Proppant processing and shipping activity growing rapidly in Western and West Central Wisconsin counties
  - Chippewa
  - Barron
  - Trempealeau
  - Jackson
  - Monroe
  - Crawford

» New announced projects
  - Superior Silica Sand – Clinton, WI
    - $35MM main line rehabilitation by CN
  - U.S. Silica – Sparta, WI
  - Smart Sand – Oakdale, WI
  - Pattison – Prairie du Chien, WI

» Minnesota areas also active
  - Southeastern border along Mississippi River
  - Western Twin Cities

» Established Illinois companies seeing significant upturns in volumes and financial returns

Source: Federal Reserve Bank of Minneapolis, July 2012; PLG analysis
Since Q3 2011, have seen an overall rail price increase of 10 - 14% in public pricing (varies by corridor).

In the 600-1,300 mile range, rates vary from $0.045 - $0.074 per ton-mile for manifest shipments.

Shippers who are willing to ship unit trains and make volume commitments have realized significant savings with longevity over public pricing.

Western carriers are driving single line hauls to Eagle Ford via pricing differentials.

Canadian and Eastern carriers are aggressively working to grow their markets by providing very competitive pricing and securing sand originations:
- CN/Superior Silica Sands – Poskin, WI

Major sand providers are establishing “in the play” transloading facilities to provide ready access to product:
- U.S. Silica - East Liverpool, OH

Source: PLG analysis
» **New-build market has run its course**
  - Much smaller backlog
    - 3Q 2011: 10,000 cars, ten month wait
    - Today: no significant wait
  - Significant drop off from ~15,000 new cars per year
  - No new spec building by lessors – all deal specific now
  - Lower pricing
  - Some new cars going into storage

» **Lease market also post-peak**
  - Existing 286K cars available now
  - Cars with sub-optimal specs (grain, <286K, cement) are being phased out of frac sand fleet
  - Creditworthiness an important criteria

» **Long-term horizon**
  - No sign of cement market return, easing pressure on small cube hopper cars
  - “Rational” vs. gold rush conditions
Frac sand is highly sensitive to logistics costs relative to past energy “booms”

As frac sand costs are decreasing, rail freight rates are increasing

- Ethanol 8%
- Wind turbine 12%
- Frac sand 58%
- Processed Sand: 42%
- Rail Freight Rate: 28%
- Rail Fuel Surcharge: 2%
- Railcar Lease: 2%
- Trucking & Transload to Drill Site: 22%
- Destination Transload: 4%

Representative logistics costs for example sand price of $180/ton

Source: PLG analysis
Shale Play Product Flows Outbound

» **Natural Gas**
  - Majority via pipelines, some trucks

» **Natural Gas Liquids (NGLs)**
  - Requires processing (fractionation)
  - 3-9 gallons/MCF (thousand cubic feet)
    - Ethane 63%
    - Propane 22%
    - Butane 8%
    - Pentane 5%
    - Other 2%

» **Crude Oil**
  - Bakken play as a model
  - Strong potential for Utica play (currently 2-3 years behind Bakken)
Bakken Oil Production - History

First outbound unit train shipment December, 2009

~670,000 BPD July 2012

Source– North Dakota Industrial Commission July 2012
North Dakota Department of Mineral Resources July 2012
Bakken Oil Production - Forecast

North Dakota Oil Production and Price

Possible
Probable
Proven

3,382 Bakken and Three Forks wells drilled and completed
35,700 more new wells possible in thermal mature area
Proven=7 BBO – Probable=10 BBO – Possible=14 BBO (billion barrels of oil)

Source: North Dakota Oil and Gas Division  May 2012
Bakken oil is a light, sweet crude with low sulfur content and low viscosity
- Requires less downstream processing
- Equal in quality to benchmark WTI
- Higher gas, jet, and distillate yield than peer crudes

Already a “game changer” in global oil market
- Bakken and WTI trading at ~$20/bbl less than Brent
- Increased unit train receiving capacity (St. James, Pt. Arthur, Cushing, Albany, Philadelphia, California, St. John, NB, Anacortes, WA) coming on line to displace waterborne crudes
- Some analysts forecasting Canada and US crude oil self-sufficiency and prices well below global levels by 2017

Figure 1. U.S. liquid fuels supply, 1970-2035 (million barrels per day)
Bakken Crude No Longer “Stranded” Due to Logistics

» Change in past 12 months
   - November 2011:
     - 2012 Bakken discount vs. WTI have ranged from $8-12 bbl
     - Undervalued due to logistics constraints “stranding” the oil
   - October 2012:
     - Bakken now priced evenly with WTI due to improved logistics

» Significant expansion of crude by rail terminal capacities in 2011-2012

» Crude by rail now a major market factor

» Tank car availability/lead time - major short term entry barrier
   - Current order backlog runs to 2Q 2014
   - Major purchases by oil majors and midstream companies
   - Extremely tight market with very high lease rates

---

<table>
<thead>
<tr>
<th></th>
<th>Crude by Rail Share</th>
<th>ND Production (bpd)</th>
<th>Crude by Rail (bpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 2010</td>
<td>15%</td>
<td>273,800</td>
<td>41,070</td>
</tr>
<tr>
<td>Dec. 2011</td>
<td>23%</td>
<td>470,290</td>
<td>108,167</td>
</tr>
<tr>
<td>June 2012</td>
<td>40%</td>
<td>610,000</td>
<td>244,000</td>
</tr>
<tr>
<td>August 2012</td>
<td>48%</td>
<td>635,127</td>
<td>317,564</td>
</tr>
</tbody>
</table>

Source: North Dakota Industrial Commission, PLG analysis

Bpd = Barrels per Day
Crude Oil by Rail Volume Growth

Rail deliveries of oil and petroleum products up 38% in first half of 2012

Average weekly U.S. rail carloads of crude oil and petroleum products
number of rail carloads per week
11,000

Note: Crude oil and petroleum products rail shipments do not include ethanol.

Quarterly Data

Source - US Rail Desktop
Crude Oil by Rail – North Dakota Terminals

(Existing and planned by December 2012)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Location</th>
<th>Loading Capacity (Barrels per Day)</th>
<th>Rail Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musket Corp</td>
<td>Dore</td>
<td>60,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Savage Services</td>
<td>Trenton</td>
<td>60,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Red River Supply</td>
<td>Williston</td>
<td>10,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Hess Oil</td>
<td>Tioga</td>
<td>60,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Plains All American</td>
<td>Manitou</td>
<td>65,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Bakken Transload</td>
<td>Ross</td>
<td>10,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>EOG</td>
<td>Stanley</td>
<td>65,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Basin Transload</td>
<td>Zap</td>
<td>20,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Bakken Oil Express</td>
<td>Dickinson</td>
<td>100,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Enserco</td>
<td>Gascoyne</td>
<td>10,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Rangeland</td>
<td>Epping</td>
<td>65,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Enbridge</td>
<td>Berthold</td>
<td>10,000</td>
<td>BNSF</td>
</tr>
<tr>
<td>Great Northern</td>
<td>Fryburg</td>
<td>60,000</td>
<td>BNSF</td>
</tr>
<tr>
<td><strong>BNSF Total Capacity</strong></td>
<td></td>
<td><strong>595,000</strong></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>Stampede</td>
<td>60,000</td>
<td>CP</td>
</tr>
<tr>
<td>Dakota Plains</td>
<td>New Town</td>
<td>40,000</td>
<td>CP</td>
</tr>
<tr>
<td>US Development</td>
<td>Van Hook</td>
<td>35,000</td>
<td>CP</td>
</tr>
<tr>
<td><strong>CP Rail Total Capacity</strong></td>
<td></td>
<td><strong>135,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total Crude by Rail Capacity</strong></td>
<td></td>
<td><strong>730,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: PLG analysis
North Dakota Class I Railroads and Crude Oil Terminals
Shale Related Rail Traffic Still Small Relative to Coal Volumes

Rail Shipments: Coal, Sand & Crude

Quarterly Data

Source: US Rail Desktop
Crude Oil Pipelines – Existing and Future

Source – CAPP Report 2011
Bakken Area Outbound Pipelines

Current Capacity (Q2 2012) - 440,000 bpd

### Announced pipeline capacity expansions

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Name</th>
<th>BBL's/day</th>
<th>Expected in service date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enbridge</td>
<td>Berthold Expansion</td>
<td>145,000</td>
<td>1Q 2013</td>
</tr>
<tr>
<td></td>
<td>Sandpiper</td>
<td>225,000</td>
<td>2015</td>
</tr>
<tr>
<td>Plains All American</td>
<td>Bakken North</td>
<td>50,000</td>
<td>1Q 2013</td>
</tr>
<tr>
<td>Saddle Butte</td>
<td>High Prairie</td>
<td>150,000</td>
<td>1Q 2014</td>
</tr>
<tr>
<td>Oneok Partners</td>
<td>Bakken Express</td>
<td>200,000</td>
<td>2015</td>
</tr>
<tr>
<td>Trans Canada</td>
<td>Bakken Marketlink</td>
<td>100,000</td>
<td>2015</td>
</tr>
<tr>
<td></td>
<td>Keystone XL</td>
<td>830,000</td>
<td>2015?</td>
</tr>
</tbody>
</table>

**Total New Pipelines:** 1,700,000

**NEW pipeline capacity expected operational:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>195,000</td>
</tr>
<tr>
<td>2014</td>
<td>150,000</td>
</tr>
<tr>
<td>2015</td>
<td>525,000</td>
</tr>
<tr>
<td>TBD (K XL)</td>
<td>830,000</td>
</tr>
</tbody>
</table>

Bpd = Barrels per Day  
Source: PLG analysis, North Dakota Governors Pipeline Summit June 14 2012 – presentation materials
Crude Oil by Rail vs. Pipeline

» Current pipeline options ~ 30-45% lower cost vs. rail

» Near-term offsetting rail advantages:
  ▪ Site permitting, construction is much quicker and easier
  ▪ Much lower capital cost and scalable
  ▪ Shorter contracts
  ▪ Transit to destination - 5-7 days via unit train vs. 30+ days via pipeline (between Bakken and US Gulf Coast)
  ▪ Origin and destination flexibility/opportunistic to new market niches

» Long-term challenges that will affect rail volumes and margins:
  ▪ Pipeline expansions
  ▪ Bakken-WTI price equilibrium
  ▪ Any significant narrowing of price differential between Brent and WTI

Source: PLG analysis
## Bakken Production vs. Outbound Logistics: 2012–2014 Projection

<table>
<thead>
<tr>
<th>Year</th>
<th>ND Production Forecast (Bpd)</th>
<th>Pipeline Capacity*</th>
<th>Rail Terminal Capacity</th>
<th>Rail Carrier Capacity</th>
<th>ND Refinery Consumption</th>
<th>Total Outbound &amp; Refinery Capacity</th>
<th>Excess Logistics Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>700,000</td>
<td>440,000</td>
<td>730,000</td>
<td>1,200,000</td>
<td>60,000</td>
<td>1,230,000</td>
<td>530,000</td>
</tr>
<tr>
<td>2013</td>
<td>790,000</td>
<td>635,000</td>
<td>800,000</td>
<td>1,300,000</td>
<td>60,000</td>
<td>1,495,000</td>
<td>705,000</td>
</tr>
<tr>
<td>2014</td>
<td>860,000</td>
<td>785,000</td>
<td>850,000</td>
<td>1,350,000</td>
<td>60,000</td>
<td>1,695,000</td>
<td>835,000</td>
</tr>
</tbody>
</table>

* Excludes Keystone XL

Bpd = Barrels per Day

Source: PLG Analysis
Crude Oil Logistics – Near Term Outlook

» Logistics capacity exceeds production and will continue to keep pace in future

» Crude by rail cost premium of .5x – 2.0x is not currently deterring volume moves

» Crude by rail is a key outbound logistics mode near-term; pipeline share of outbound Bakken production will grow annually and impact rail longer term (volumes and margin)

» Expected Seaway pipeline 250,000 bpd expansion in 1st quarter 2013 will relieve much Cushing congestion and likely will put additional pressure on railroad pricing to compete with expanded pipeline economics and availability

» Long term, the rail transportation cost premium will likely impact rail volumes as pipe vs. rail differential increases
Looking Ahead: Key Questions for Oil & Gas Supply Chain

» Shale play dynamics
  ▪ Influenced by supply/demand market fluctuations
  ▪ Crude vs. dry gas vs. NGL
  ▪ Potential environmental concerns

» Where are the destinations for further processing?
  ▪ Crude oil refineries – sweet vs. sour processing
  ▪ NGL fractionation
  ▪ Petrochemical manufacturing investments
  ▪ Increased CNG demand
  ▪ Crude, NGL, and LNG exports

» Will transportation services, assets, and infrastructure continue to meet demand?
  ▪ Pipeline locations and capacity
  ▪ Road and rail infrastructure
  ▪ Waterway availability
  ▪ Fleet assets
  ▪ Terminals and storage

Source: RBN Energy, LLC
Thank You!

For follow up questions and information, please contact:

Graham Brisben, CEO
+1-708-386-0700 / gbrisben@prologisticsgroup.com

Taylor Robinson, President
+1-508-982-1319 / trobinson@prologisticsgroup.com

Jean Arndt, Vice President
+1-630-505-0273 / jarndt@prologisticsgroup.com

Jeff Dowdell, Senior Consultant
+1-732-995-6696 / jdowdell@prologisticsgroup.com

Gordon Heisler, Senior Consultant
+1-215-620-4247 / gheisler@prologisticsgroup.com

Jeff Rasmussen, Senior Consultant
+1-317-379-5715 / jrasmussen@prologisticsgroup.com

This presentation is available at:
WWW.PROLOGISTICSGROUP.COM