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Energy Policy Research Foundation, Inc. (EPRINC)

EPA Brown Bag Lunch Presentation

November 12th, 2014

Understanding Crude Oil Transportation by Rail

Photo by Justin Kringstad

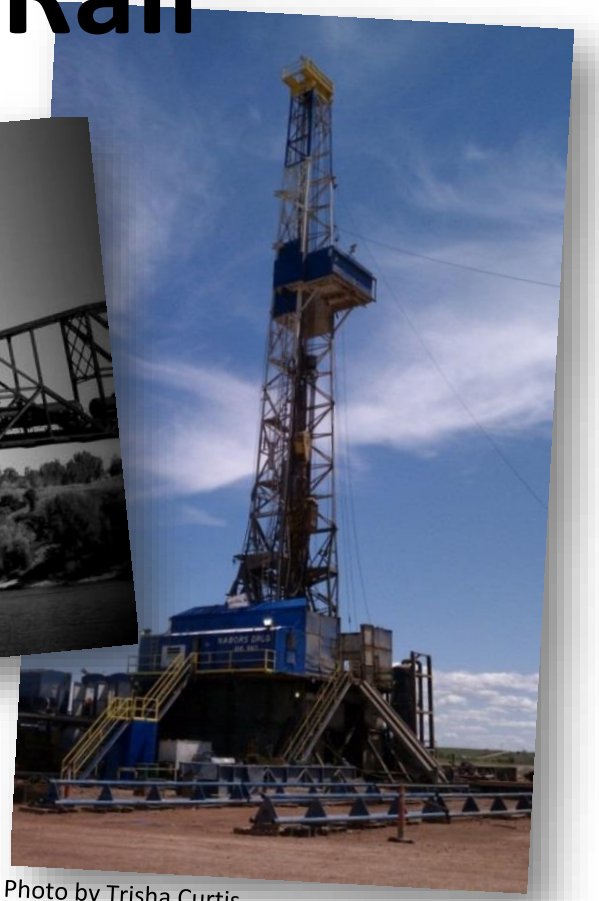
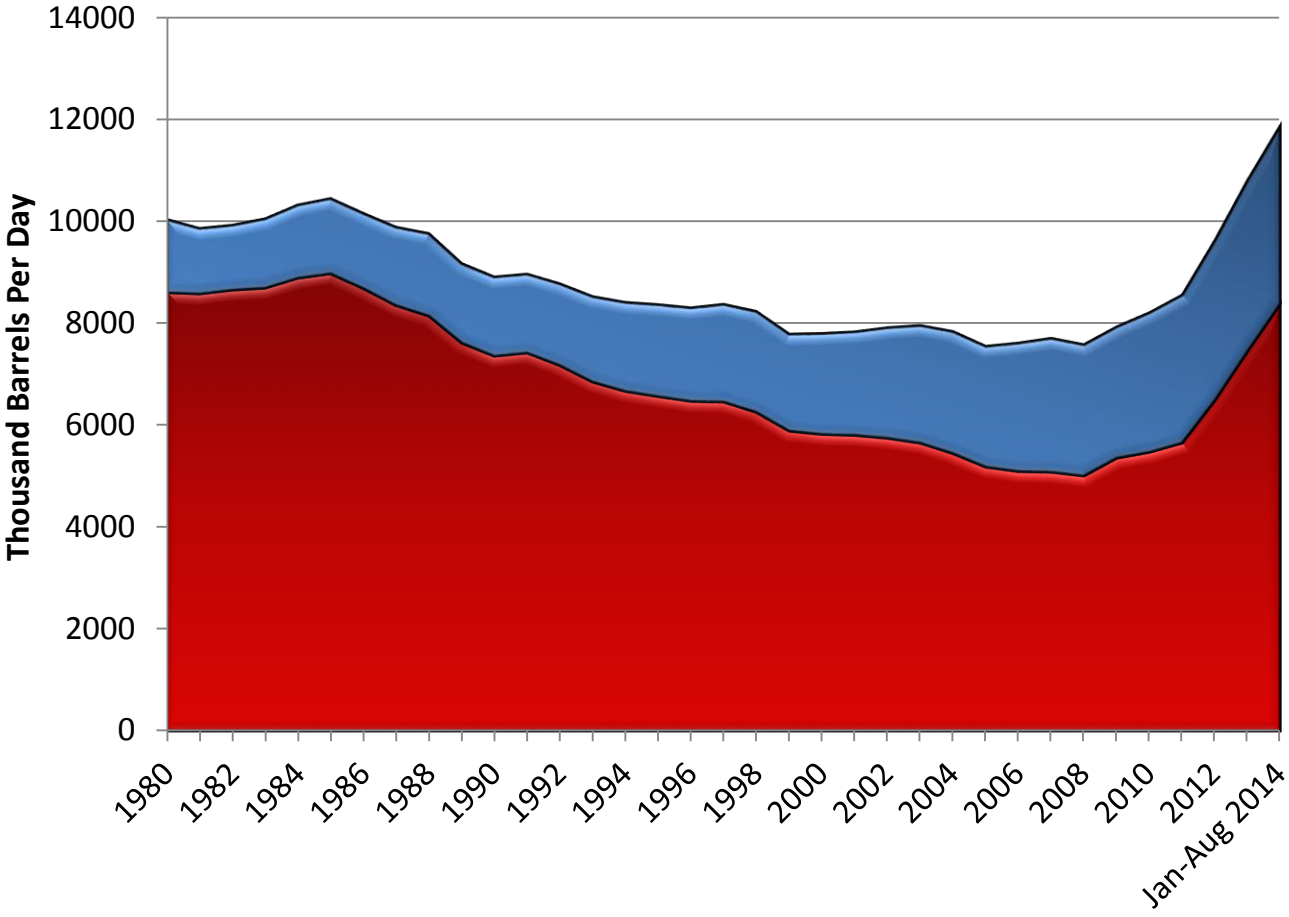


Photo by Trisha Curtis

About EPRINC

- www.eprinc.org
- Infrastructure Paper http://eprinc.org/wp-content/uploads/2013/10/EPRINC-PIPELINES-TRAINS-TRUCKS-OCT31.pdf
- Oil and Gas Journal
- Embassy Series
- Presentations at Imperial College London, Colombia University, Wyoming Pipeline Authority
- Department of Energy – Quadrennial Energy Review
- Department of Defense
- Rin App http://eprinc.org/2014/02/rins-around-rosy-app-available-ios/

North American Oil Production

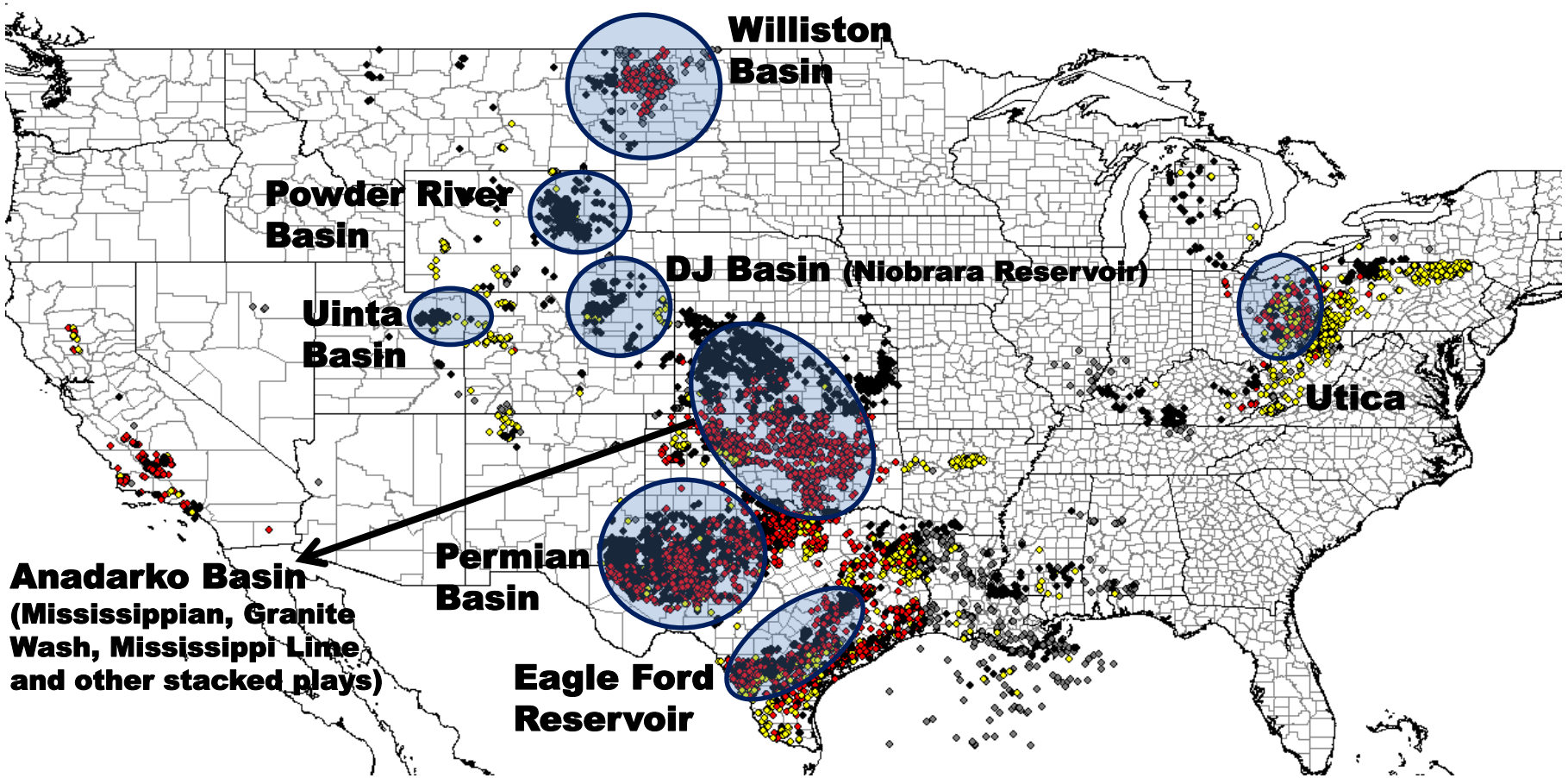


U.S. 8.7 mbd
Canada 3.5 mbd

August North America = 12.2 mbd

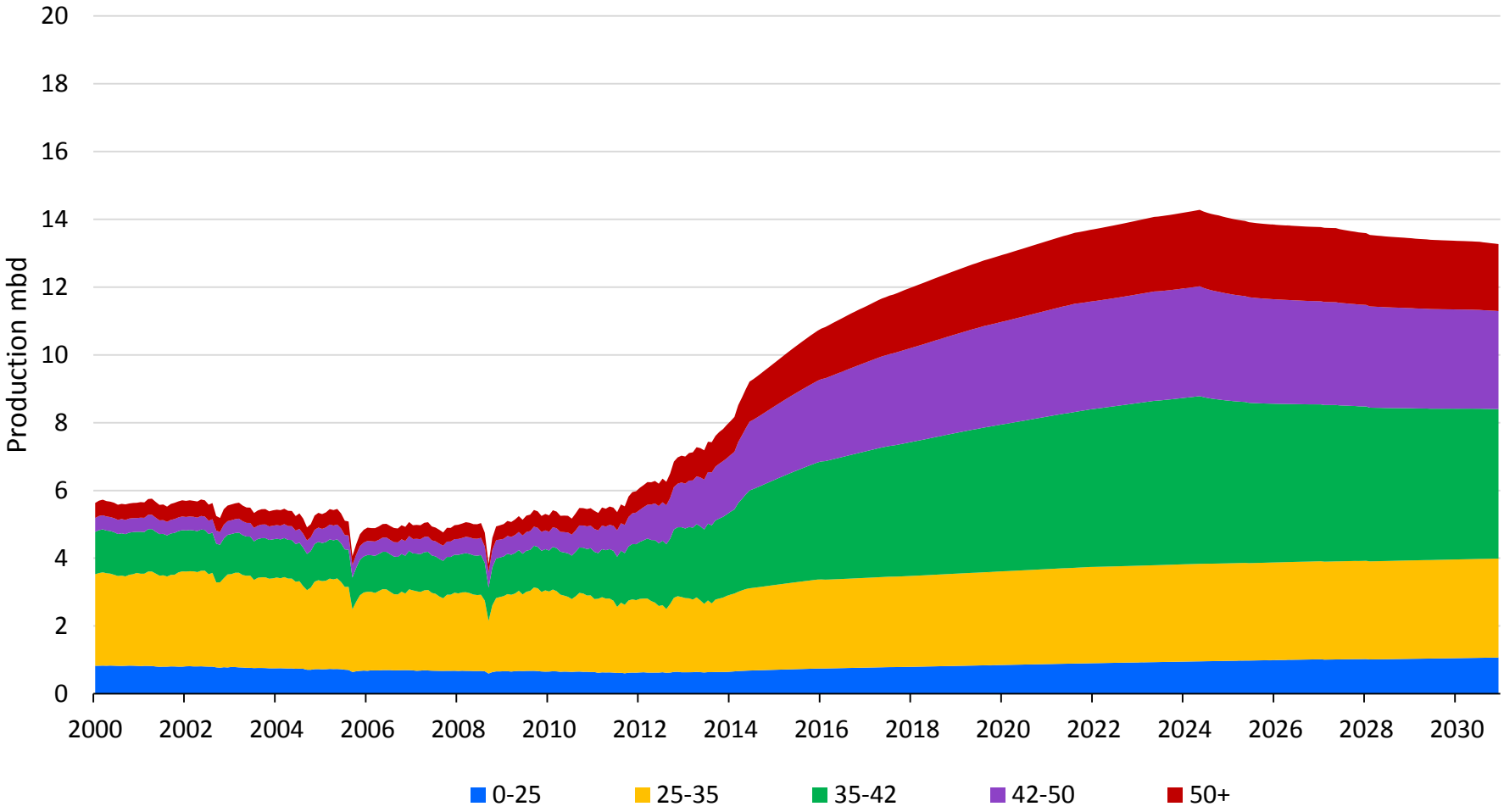
Source: EIA

Permit Activity



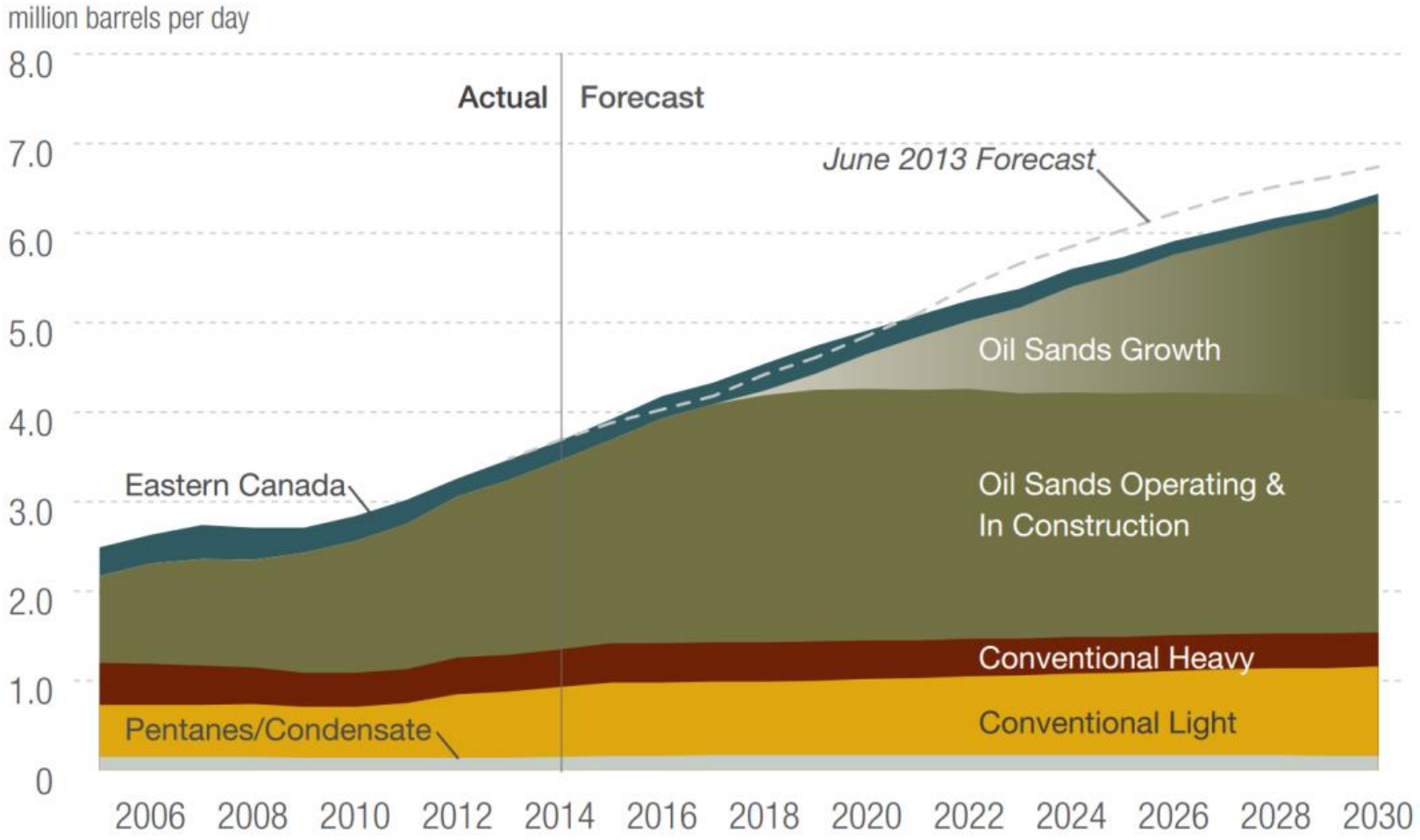
Source: HPDI Oct 2014, Past 90 Days

EPRINC Production Evaluation



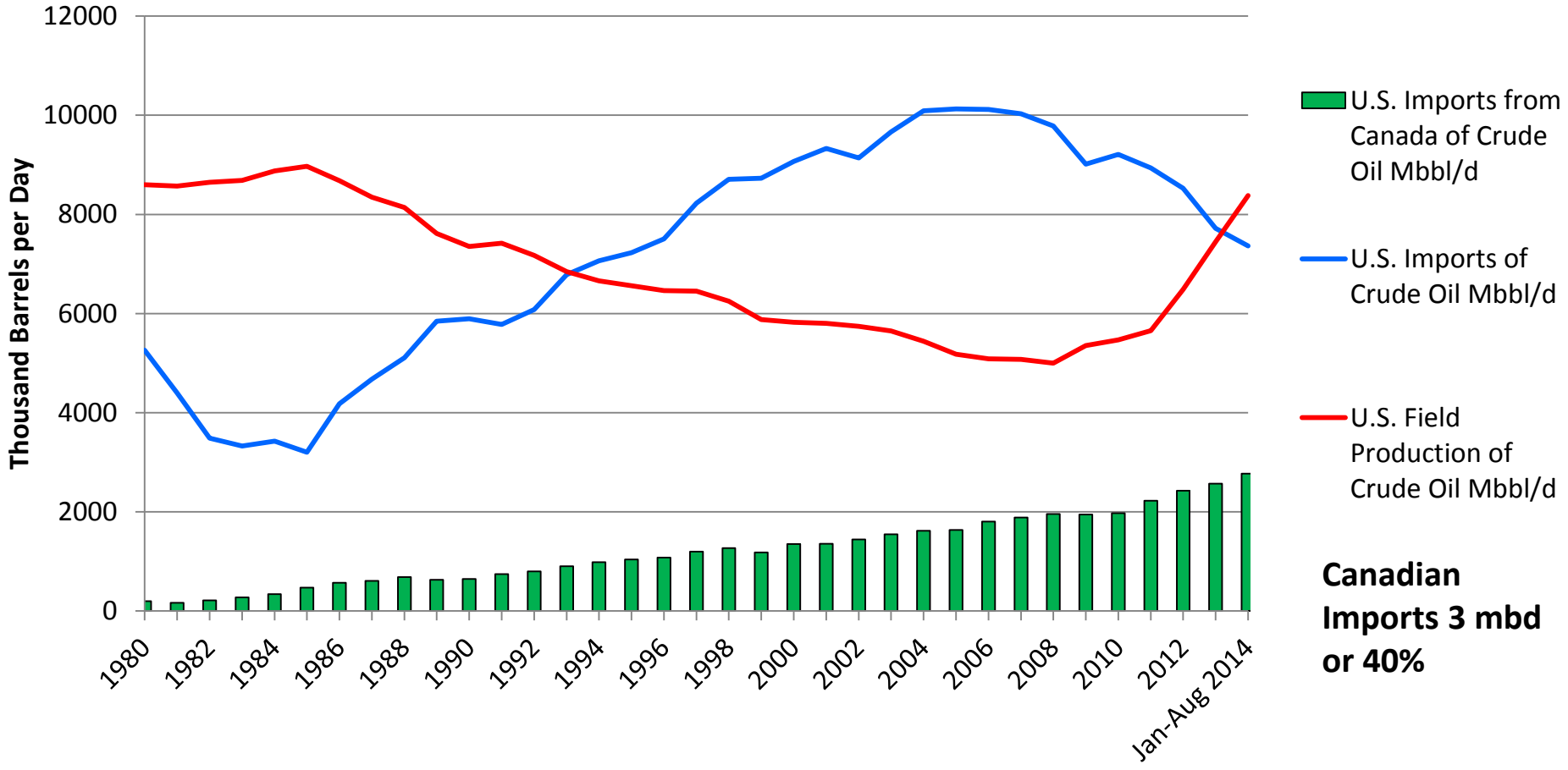
Source: EPRINC/Ponderosa

CAPP's Canadian Crude Oil Forecast



Source: CAPP 2014, "Crude Oil Forecast. Markets, and Transportation"

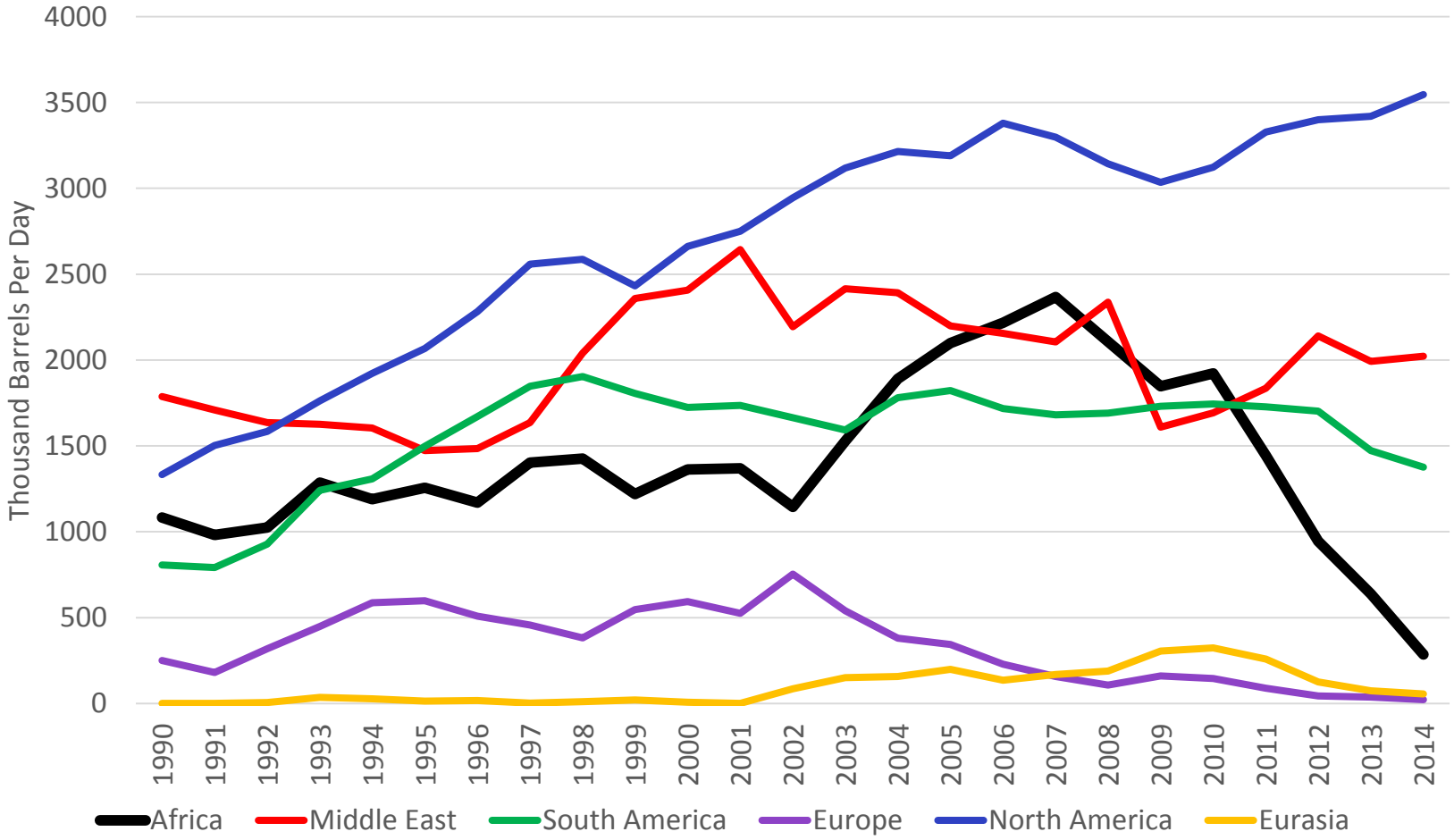
Total Imports, Production, Canadian Imports



Canadian Imports 3 mbd or 40%

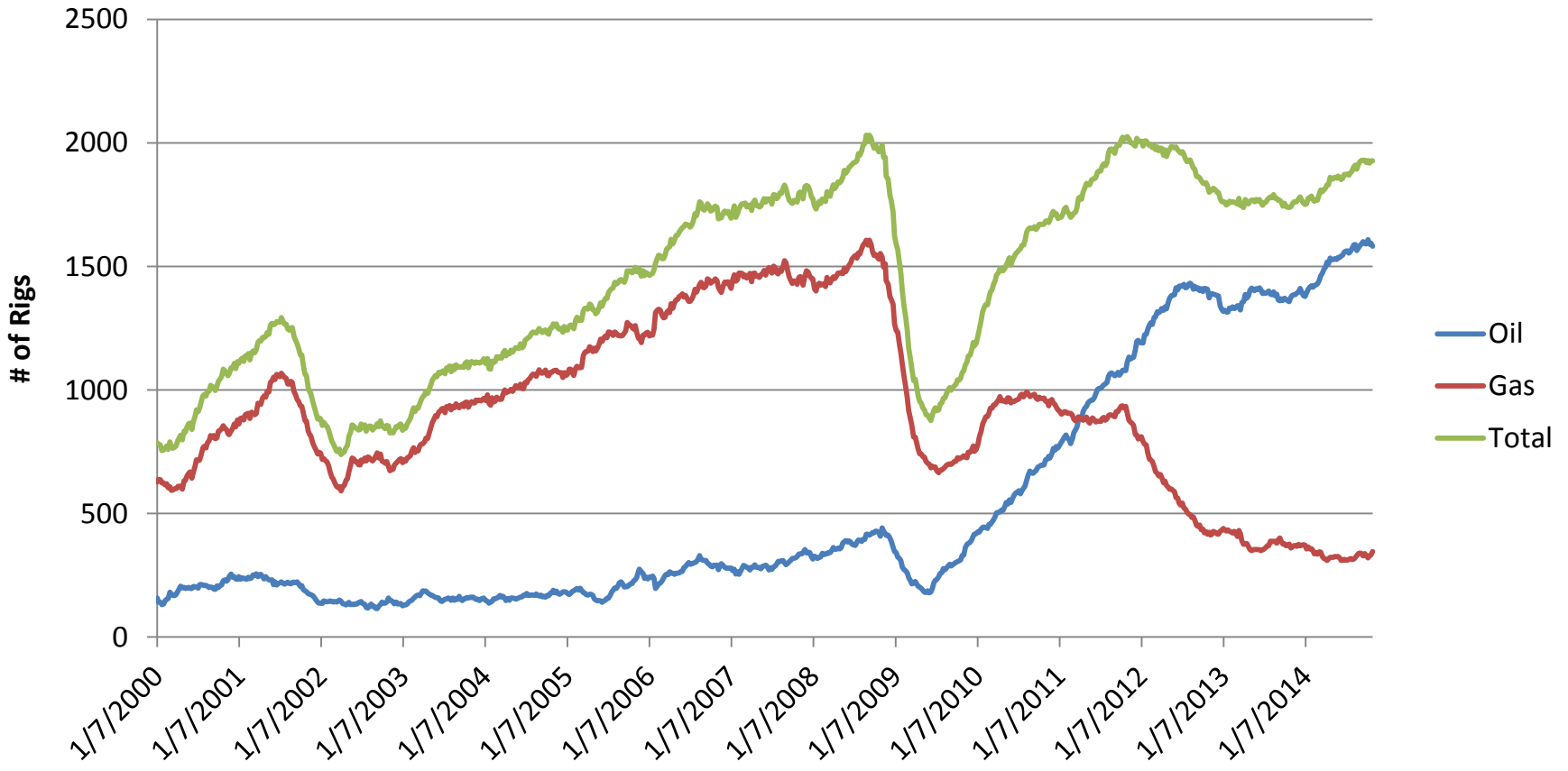
Source: EIA

U.S. Imports from Abroad Steadily Decline



- Impact on prices as African crude is pushed out and now onto world market

U.S. Rig Count



Source: Baker Hughes

Drilling Then and Now

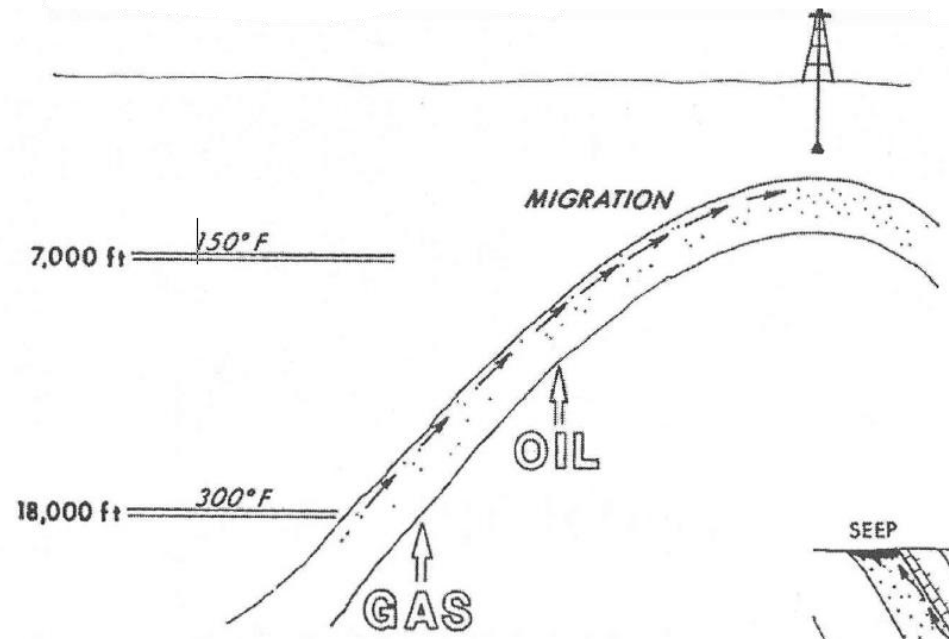


Figure I–1 Generation of oil and gas

Source Rocks

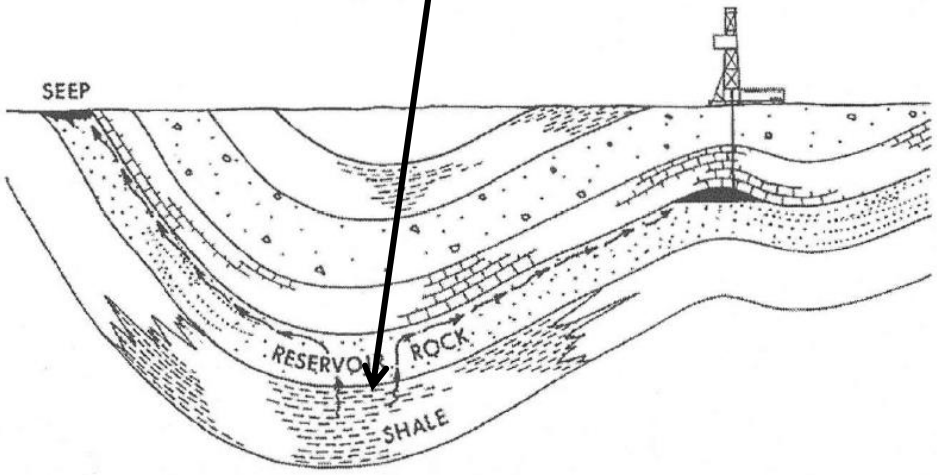
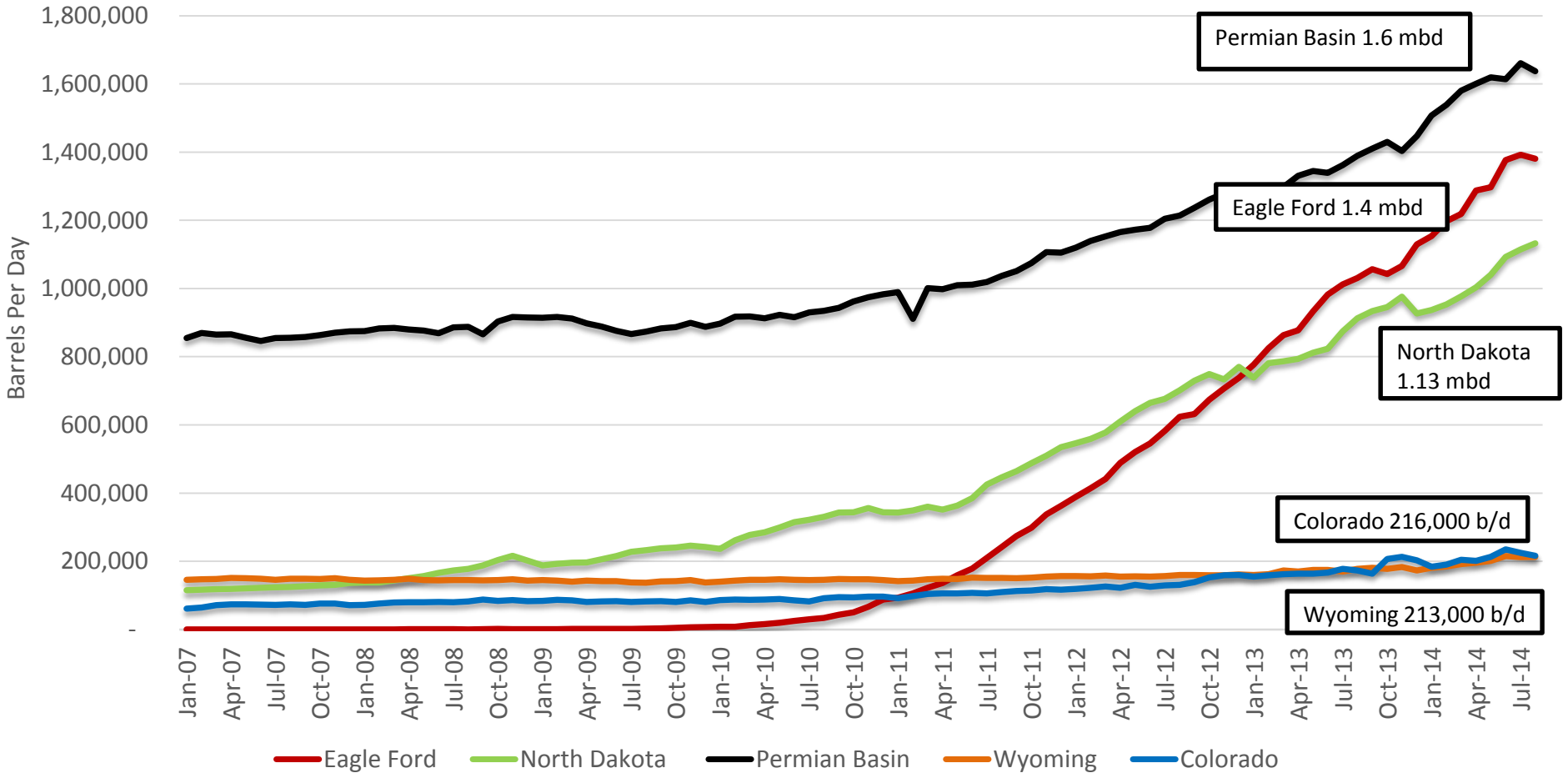


Figure 11–2 Migration of oil and gas in a sedimentary basin

Source: From PIECE Course Workbook, Mark J Kaiser, Houston, July 2008, "Introduction to USA Petroleum Industry"

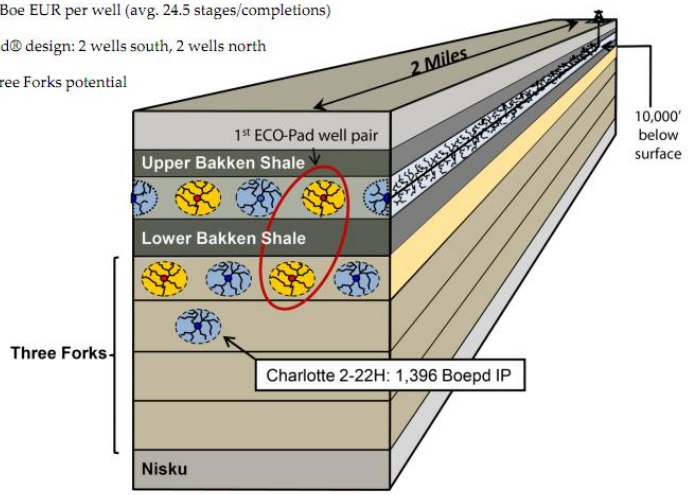
Shale Oil Play Production



Source: HPDI Nov 2013, EIA, NDPA

Drilling Advances

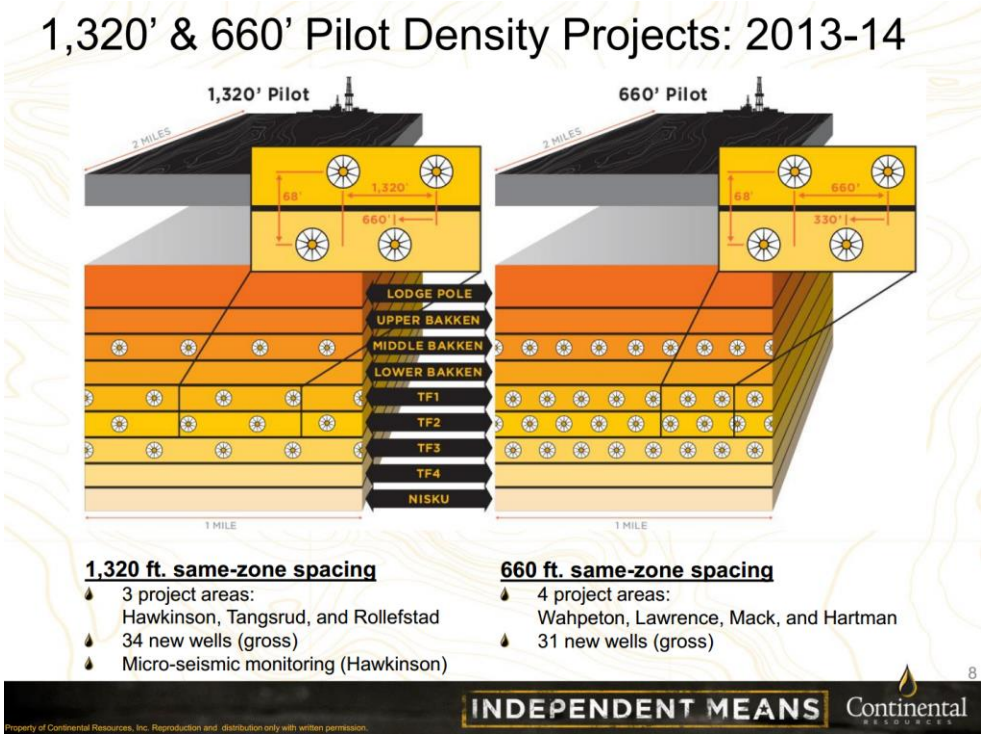
- Original dual-zone development plan
  - 8 wells per 1,280 acres – 4MB, 4TF
  - 603,000 Boe EUR per well (avg. 24.5 stages/completions)
  - ECO-Pad® design: 2 wells south, 2 wells north
- Additional Three Forks potential



Source: Continental Resources Inc., Corporate Presentation, 2012.

TRIANGLE PETROLEUM CORPORATION

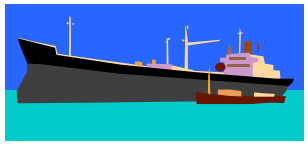
Source: Triangle Petroleum Corporation, Presentation Bakken Product Markets and Take-Away Denver Jan 31-Feb 1 2012

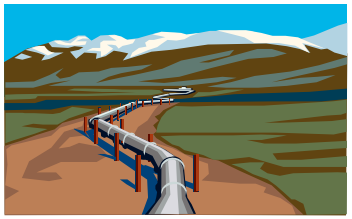


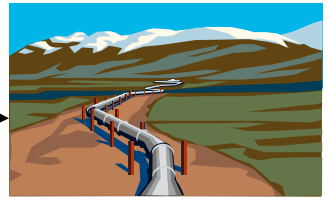
Source: Continental Resources March Investor Presentation, Permission granted

How is Crude Moved and Why?

Transportation Methods of Crude Oil and Petroleum Products

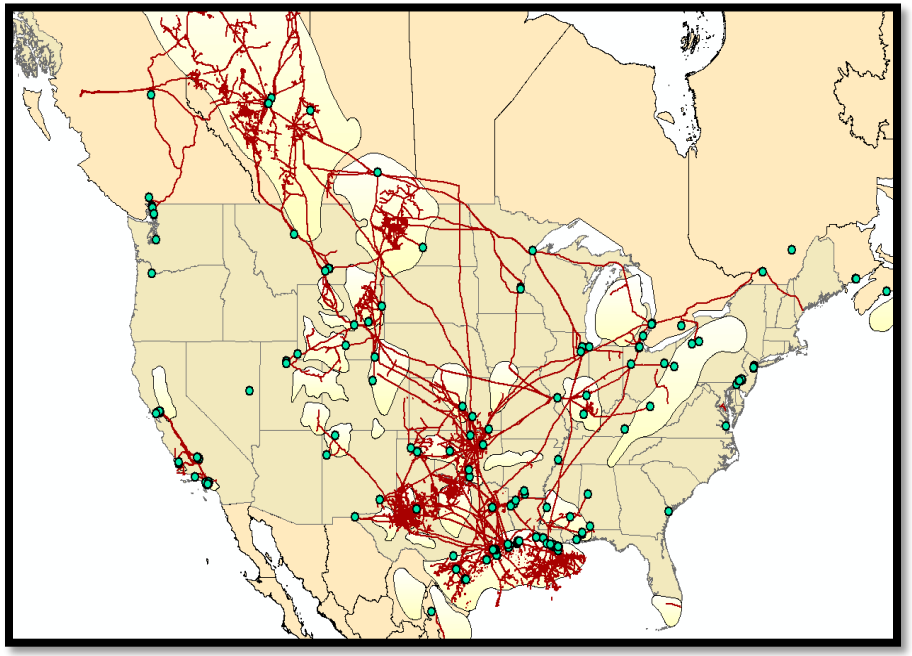


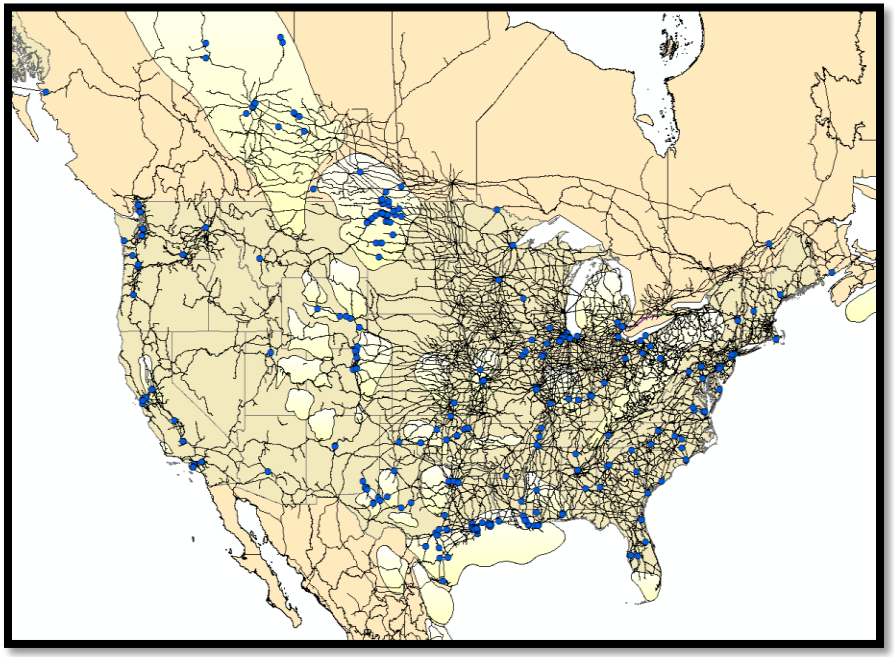




Moved from tank storage at the wellhead to refineries via pipeline, truck, rail, barge, or all four methods in combination

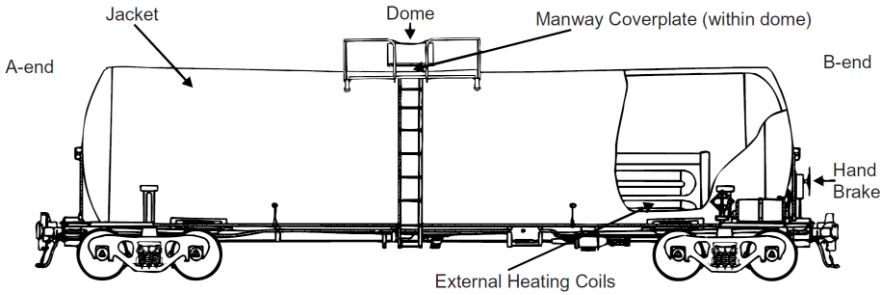
Why transport crude oil via rail?





Source: EPRINC Maps using Hart Energy data and ArcGIS Mapping software

How much crude oil does a tank car hold?



Source: DOT 111, Wikipedia

- One tank car holds about 700 barrels of crude oil (might be more or less depending on design, thickness of tank, heated tank car for bitumen, etc.)
- Unit Train = 120 tank cars of one product (scalability to maximize efficiency and reduce cost) = 84,000 barrels
- Manifest Train = Less than 100 tank cars, can be multiple commodities, not as economic, but used widely in beginning of crude by rail movement because some refineries and facilities were already equipped to handle manifest train shipments

Pipeline vs. Rail Costs

Pipeline Tolls for Light Oil (US$ per barrel)

Edmonton to	
Burnaby (Trans Mountain)	2.55
Anacortes (Trans Mountain/Puget)	2.80
Sarnia (Enbridge)	4.00
Chicago (Enbridge)	3.60
Wood River (Enbridge/Mustang/Capwood)	5.00
USGC (Enbridge/Spearhead/Seaway)	7.65*
Hardisty to	
Guernsey (Express/Platte)	1.60*
Wood River (Express/Platte)	1.95*
Wood River (Keystone)	4.70**
USGC (Keystone/TC Gulf Coast)	7.00**
USEC to Montréal (Portland/Montréal)	1.50
St. James to Wood River (Capline/Capwood)	1.25

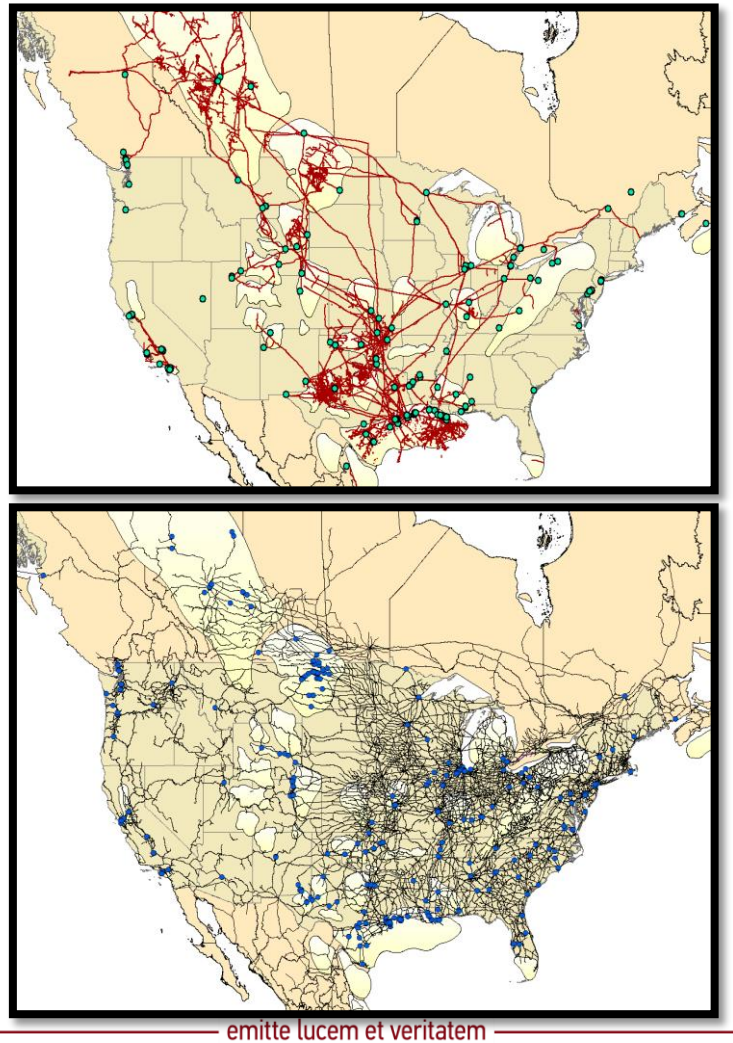
Pipeline Tolls for Heavy Oil (US$ per barrel)

Hardisty to:	
Chicago (Enbridge)	4.05
Cushing (Enbridge/Spearhead)	5.20
Cushing (Keystone)	6.15**
Cushing (Keystone)	6.50*
Wood River (Enbridge/Mustang/Capwood)	5.85
Wood River (Keystone)	5.35**
Wood River (Express/Platte)	2.40*
USGC (Enbridge/Spearhead/Seaway)	8.65*
USGC (Keystone/TC Gulf Coast)	7.95**

Notes 1) Assumed exchange rate = 0.92 US$ / 1C$ (May 2014 average)
2) Tolls rounded to nearest 5 cents
3) Tolls in effect July 1, 2014

* 10-year committed toll
**20-year committed toll

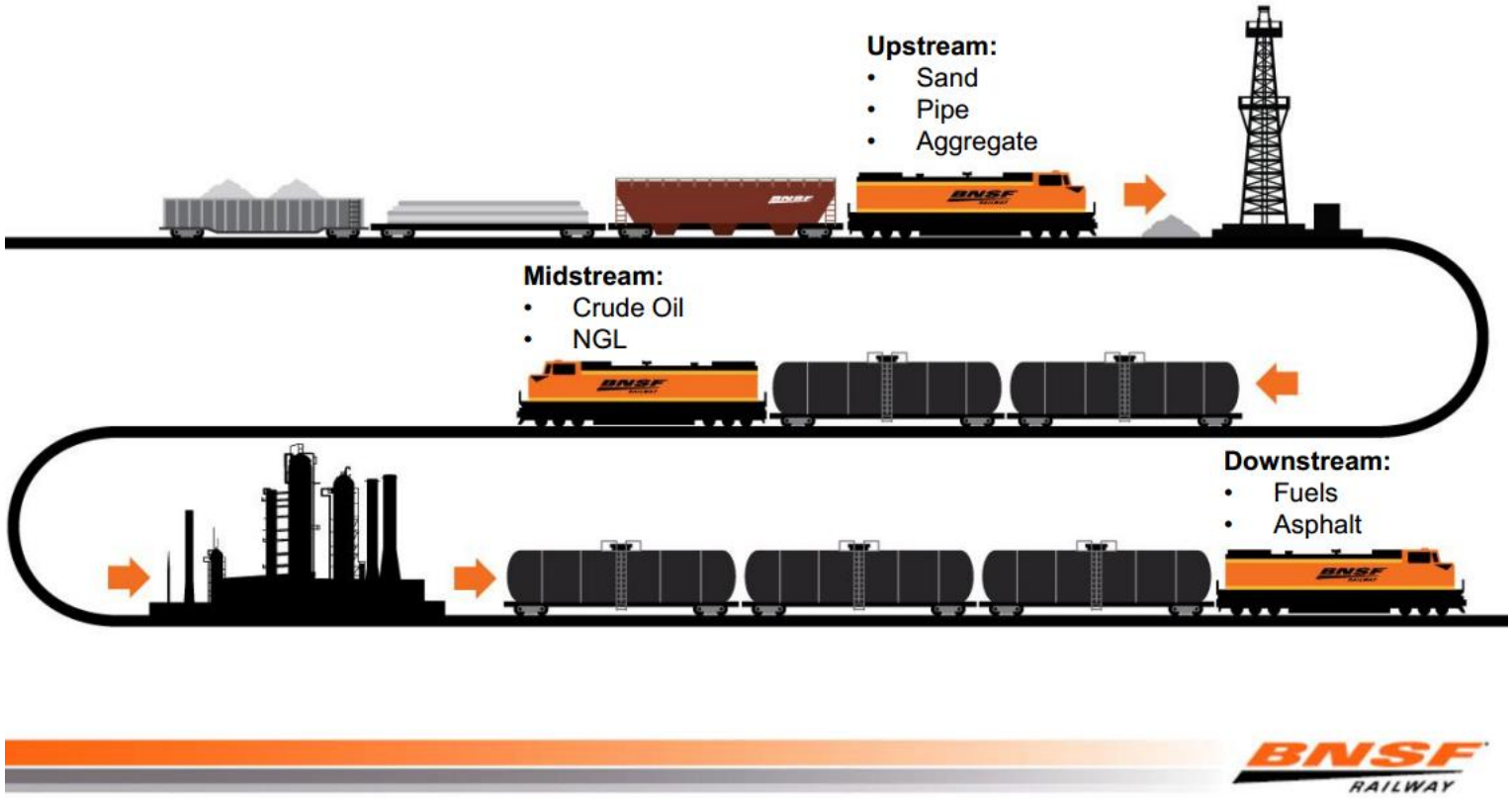
Source: CAPP 2014 Forecast



- From Bakken to Coasts between $10 - $15
- Slight increases due to fees by railroads for older tank cars and testing fees
- From Alberta to Gulf $20

Source: EPRINC Maps using Hart Energy data and ArcGIS Mapping software

Role of rail in upstream, midstream, and downstream

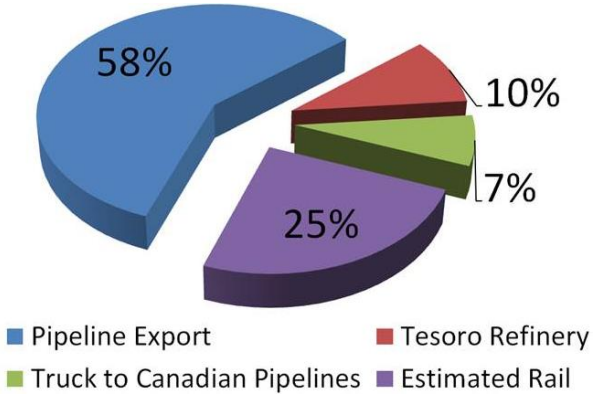


Source: BNSF Presentation, Sept 2013, via DOT website

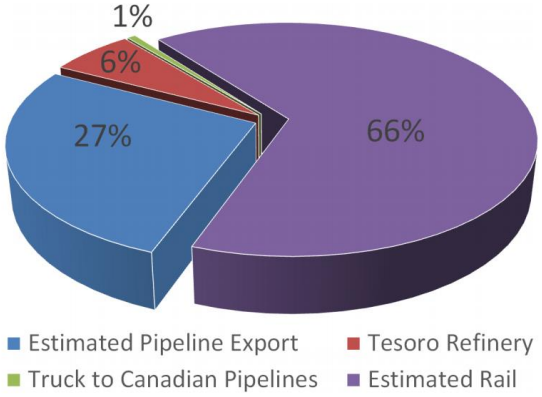
Infrastructure and Pricing

North Dakota Crude Oil Transport

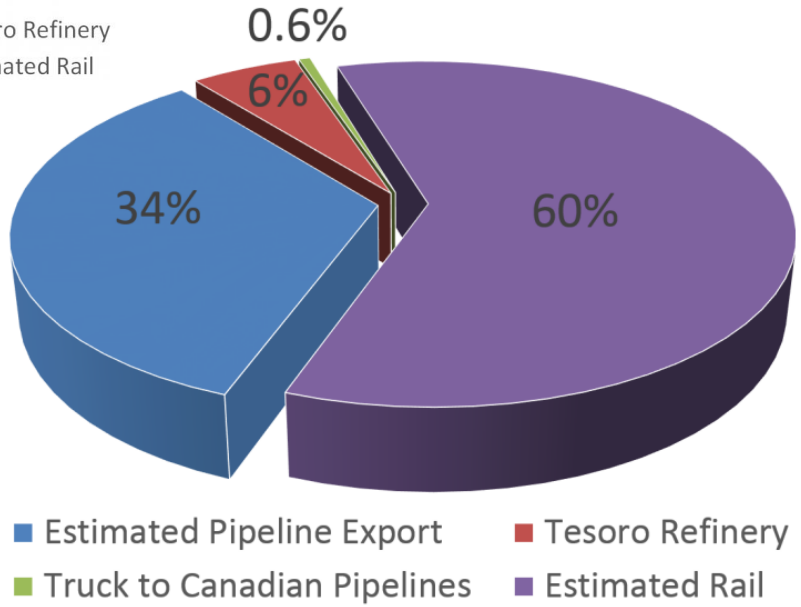
January 2012 Estimates



March 2014 Estimates



Aug 2014 Estimates



Source: North Dakota Pipeline Authority

July 2014 Williston Basin Crude Transportation

Williston Basin Production: 1.2 mbd
North Dakota: 1,132,331 b/d
South Dakota: 4,675 b/d
Eastern Montana: 75,162 b/d

Tesoro Refinery: 68,000 b/d

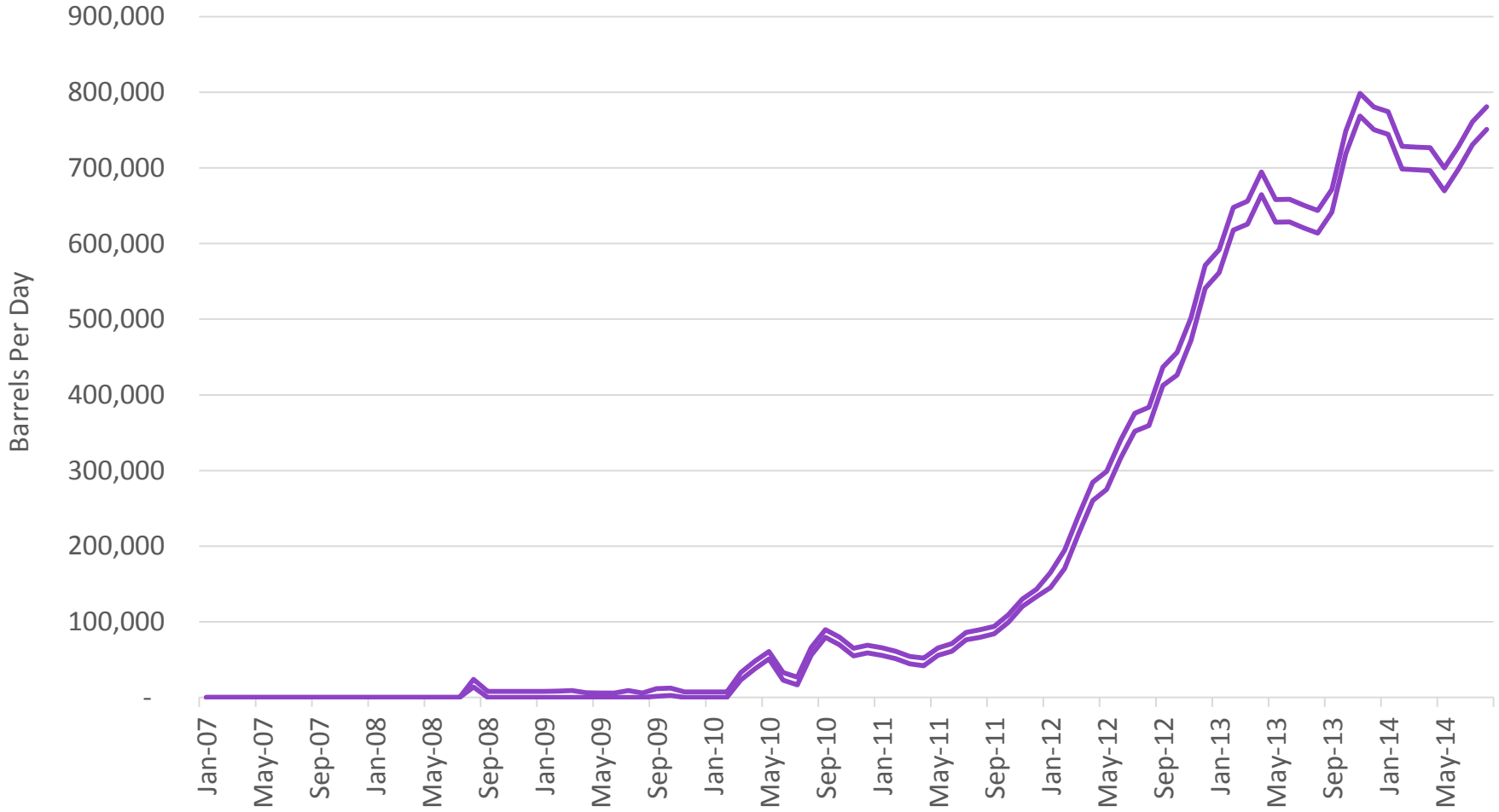
Truck to Canadian Pipeline: 8,000 b/d

Rail: 766,000 b/d

Pipeline: 432,168 b/d

Source: NDPA, EPRINC Estimates

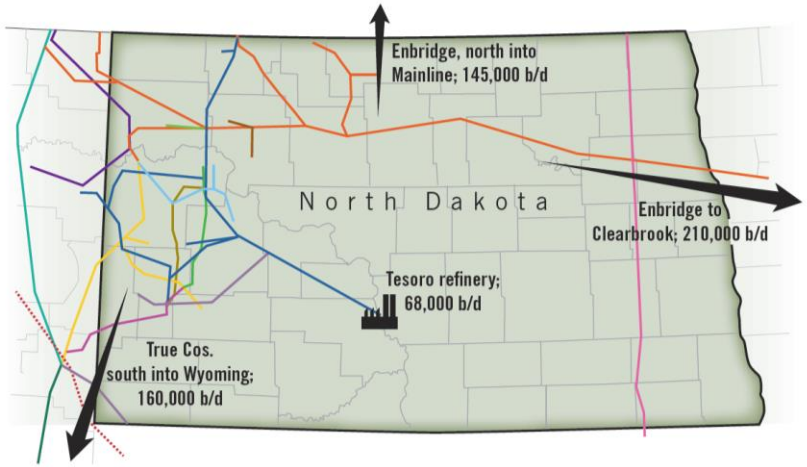
Williston Basin Rail Estimates



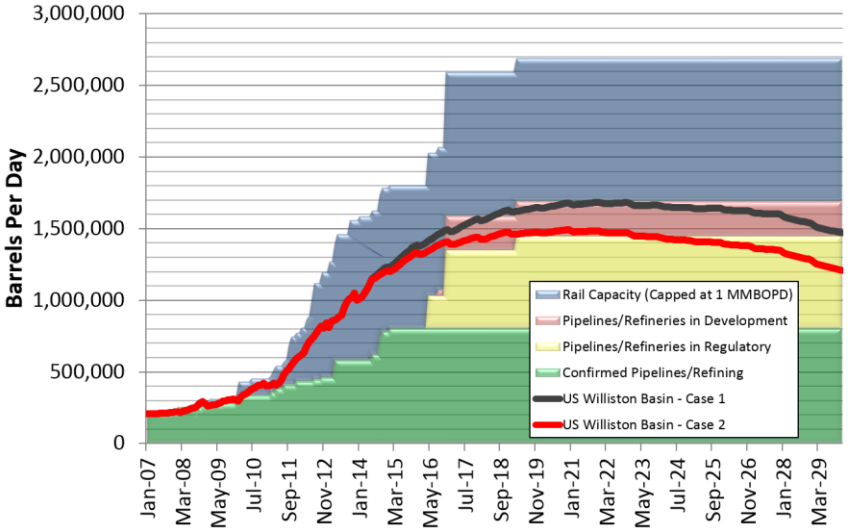
Source: NDPA

Pipeline Capacity Ample

- Plenty of pipeline capacity *now*, but if more crude should move back to pipe (continued rail concerns regarding Dec regulation uncertainty) could see prices further decline in Clearbrook and in Wyoming

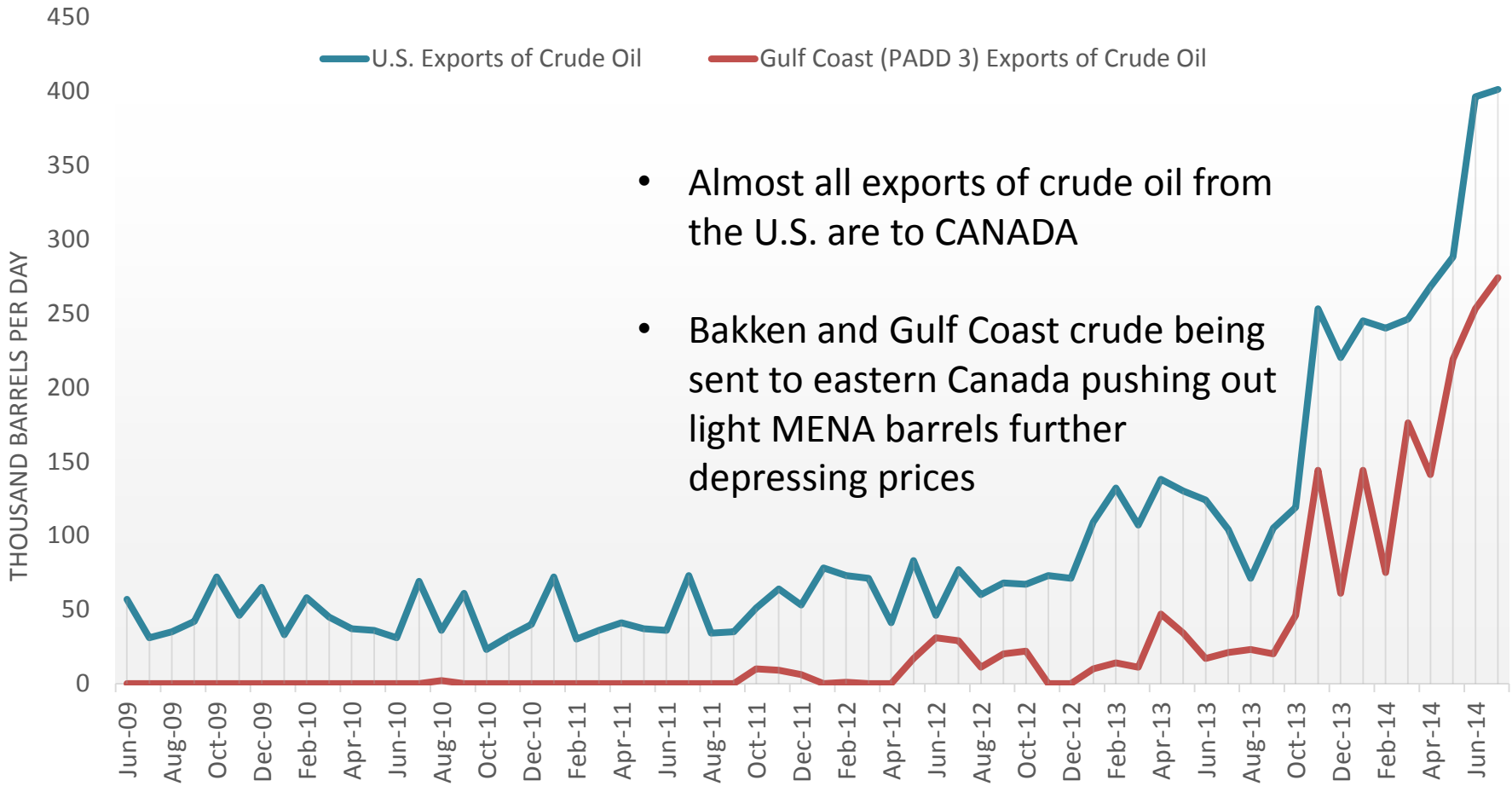


Source: North Dakota Pipeline Authority, EPRINC



Source: EPRINC's article in Oil and Gas Journal March 2014

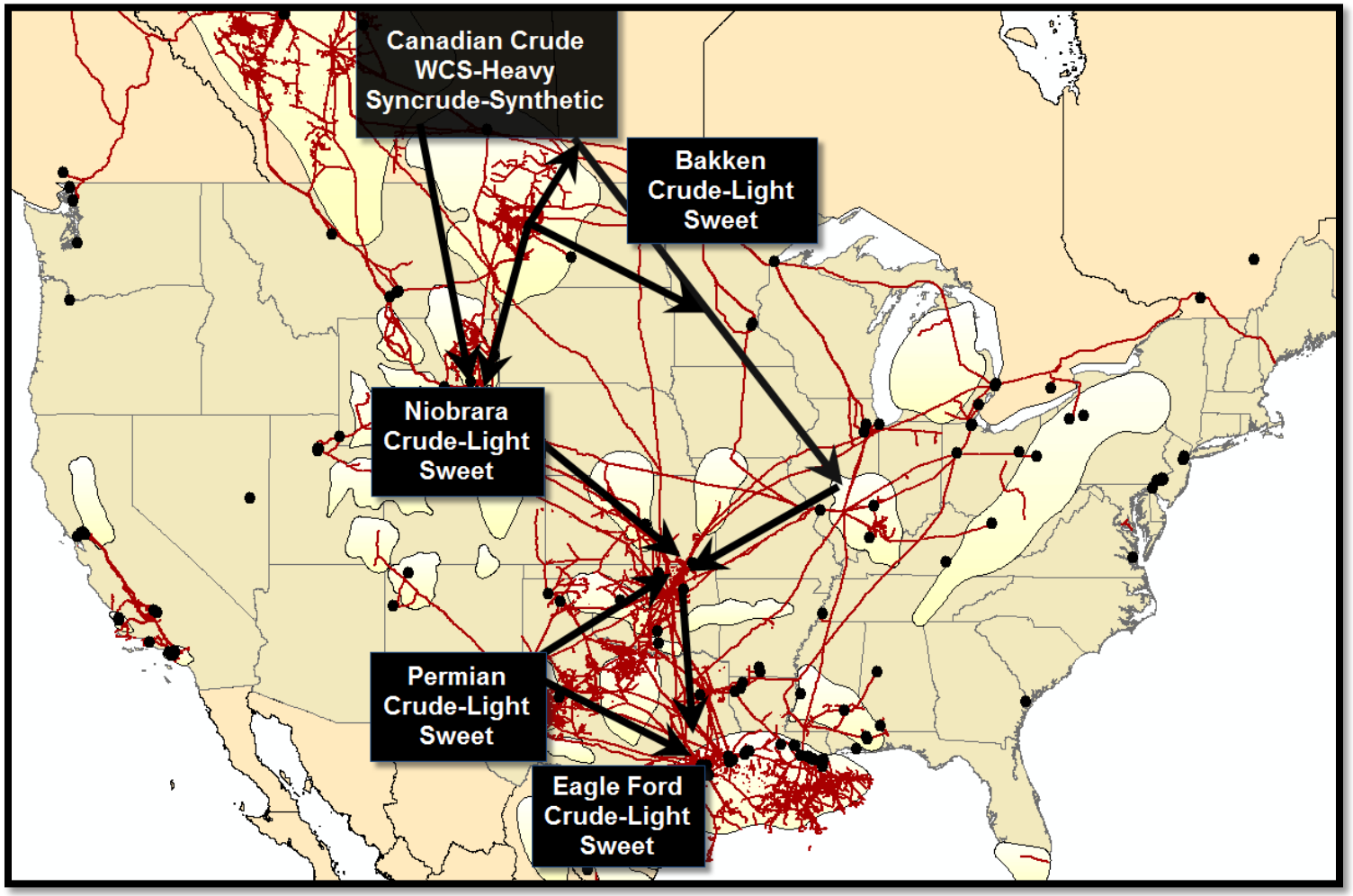
U.S. Crude Oil Exports…from PADD III



- Almost all exports of crude oil from the U.S. are to CANADA
- Bakken and Gulf Coast crude being sent to eastern Canada pushing out light MENA barrels further depressing prices

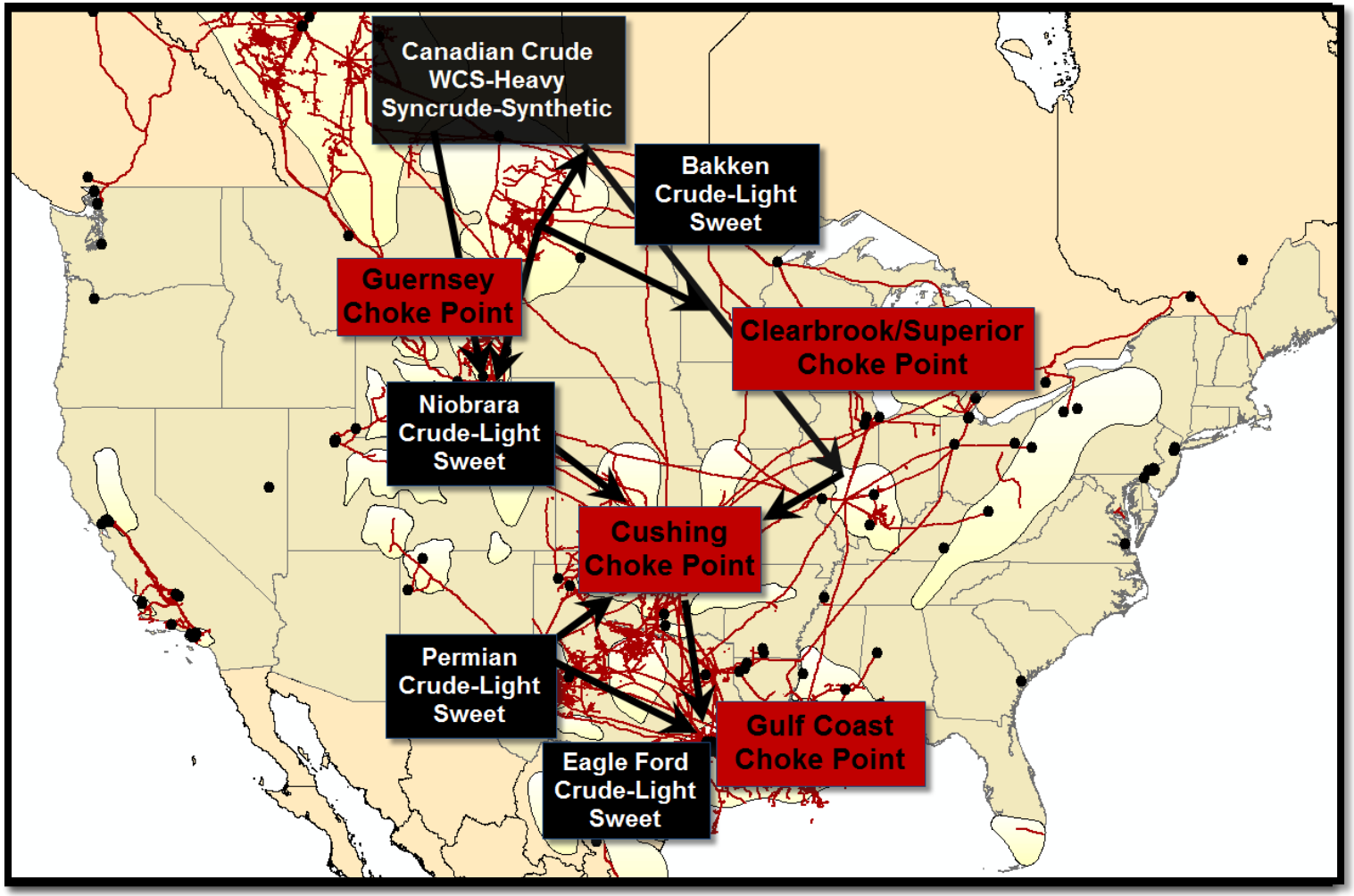
Source: HPDI Aug 2014

Major Canadian and Shale Oil Crude Flows



Source: EPRINC Choke Point Map using Hart ArcGIS Mapping software

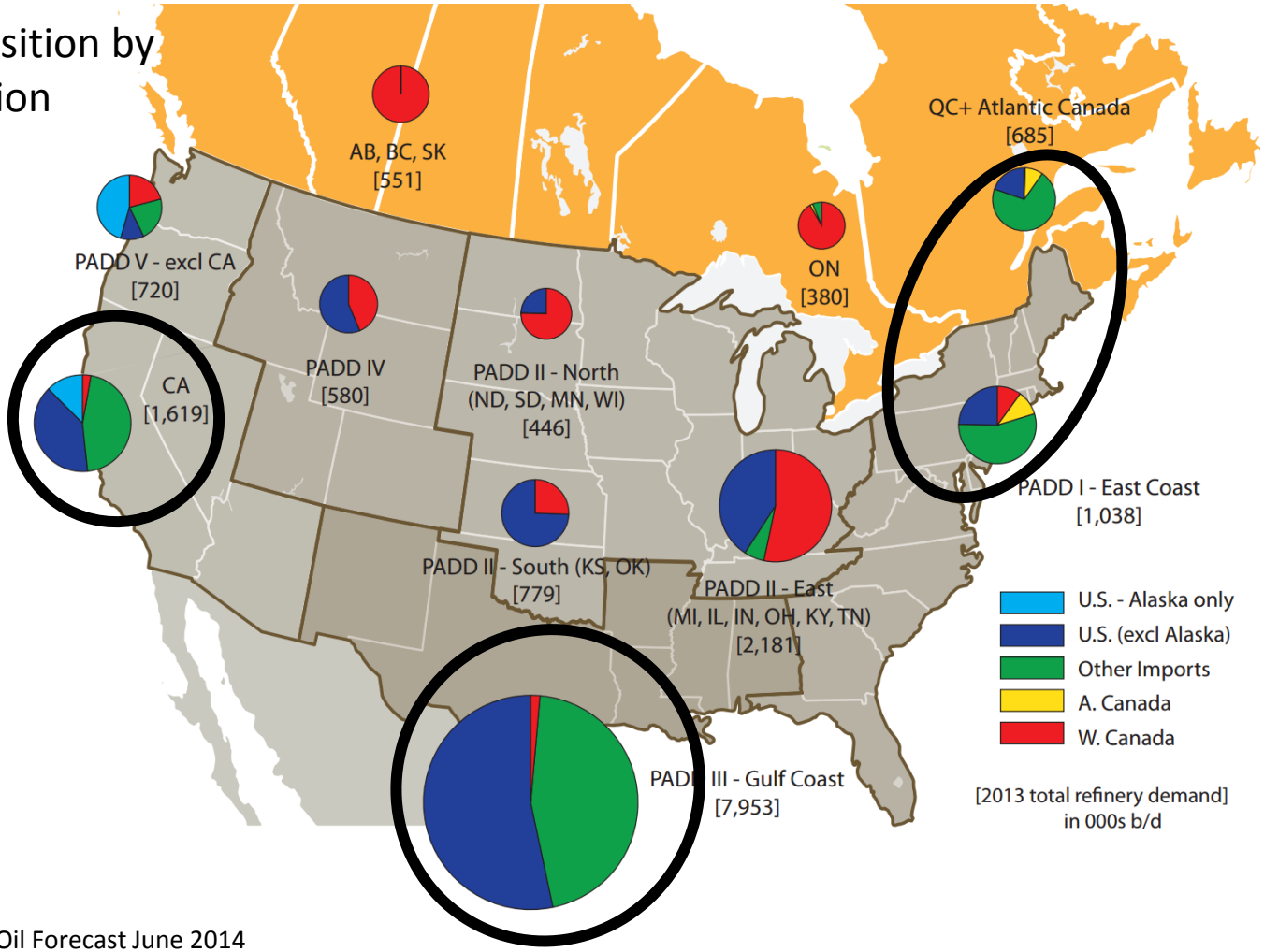
Pipeline Choke Points



Source: EPRINC Choke Point Map using Hart ArcGIS Mapping software

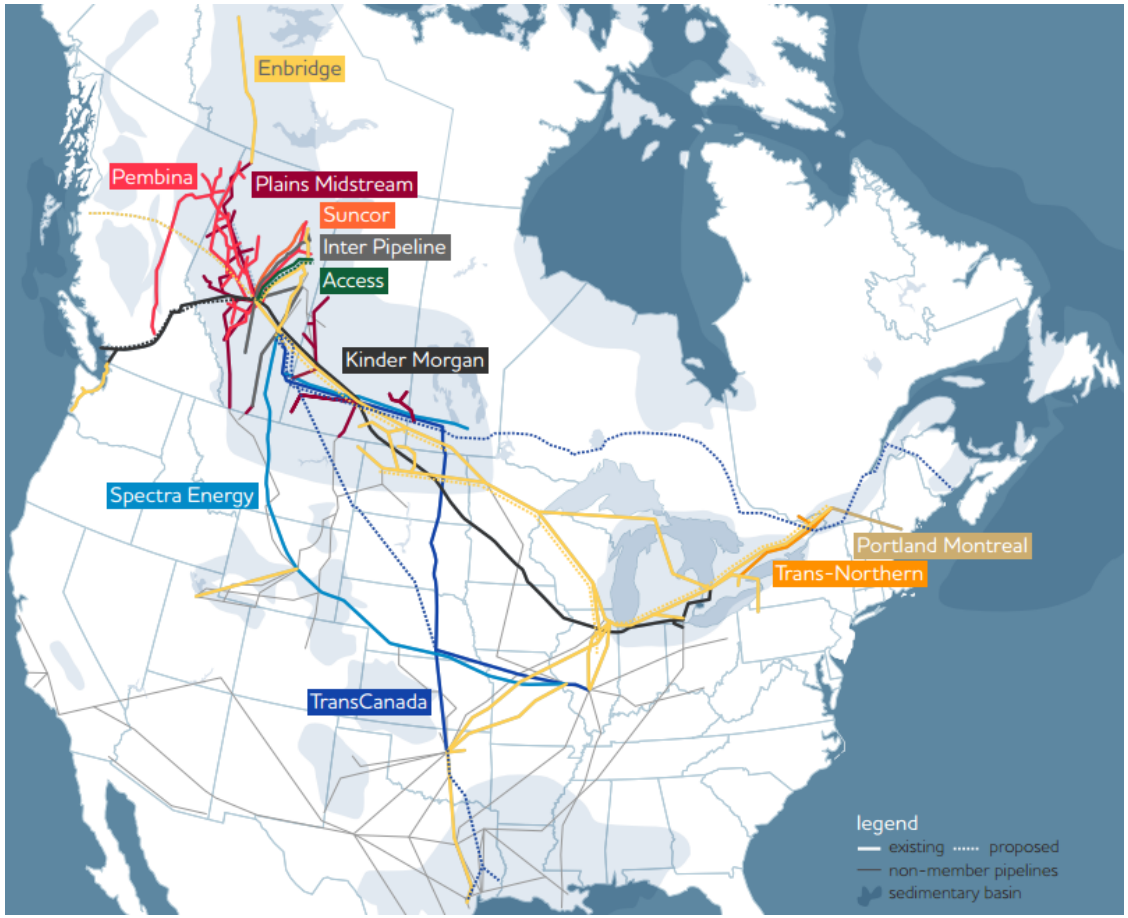
No place to go….

Crude disposition by refinery region



Source: CAPP Crude Oil Forecast June 2014

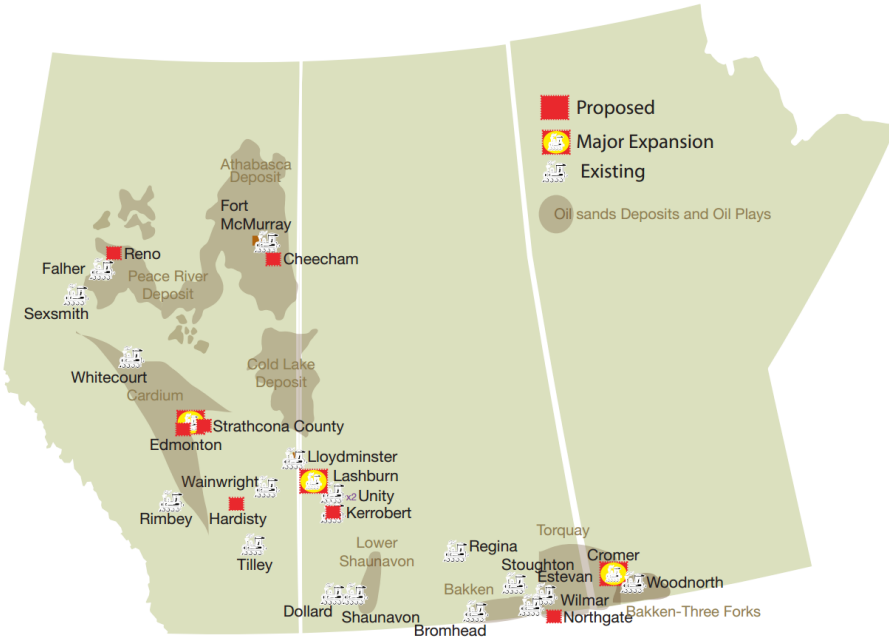
All Canadian Pipeline Export Options are Full

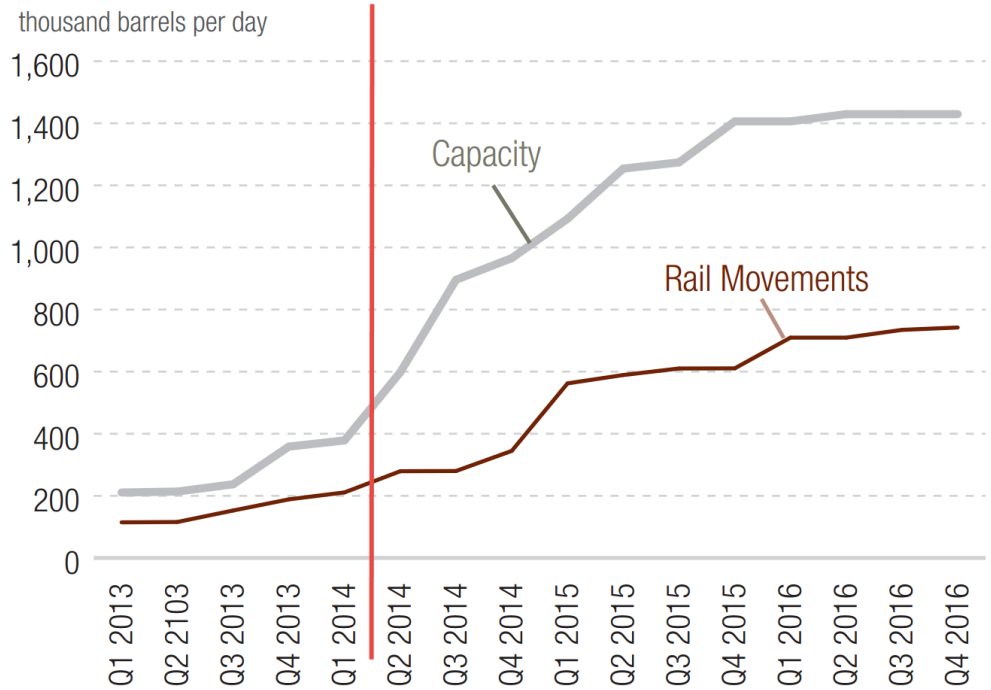


- **Kinder Morgan's** Transmountain line off BC coast - currently 300,000 b/d capacity- planned expansion up to 800,000 b/d (early 2017)
- **(Now Spectra)** Platte line to Wood River 280,000 b/d-full
- **Enbridge** mainline system currently transporting over 1.5 mbd with potential capacity around 2.5 mbd—Northern Gateway off BC coast planned 525,000 b/d, several other planned expansions, light oil access +400,000 b/d to eastern U.S. and Canada
- **TransCanada's** Keystone 581,000 b/d-full—XL would add 700,000 b/d, Energy East Pipeline Project 1.1 mbd

Source: Canadian Energy Pipeline Association

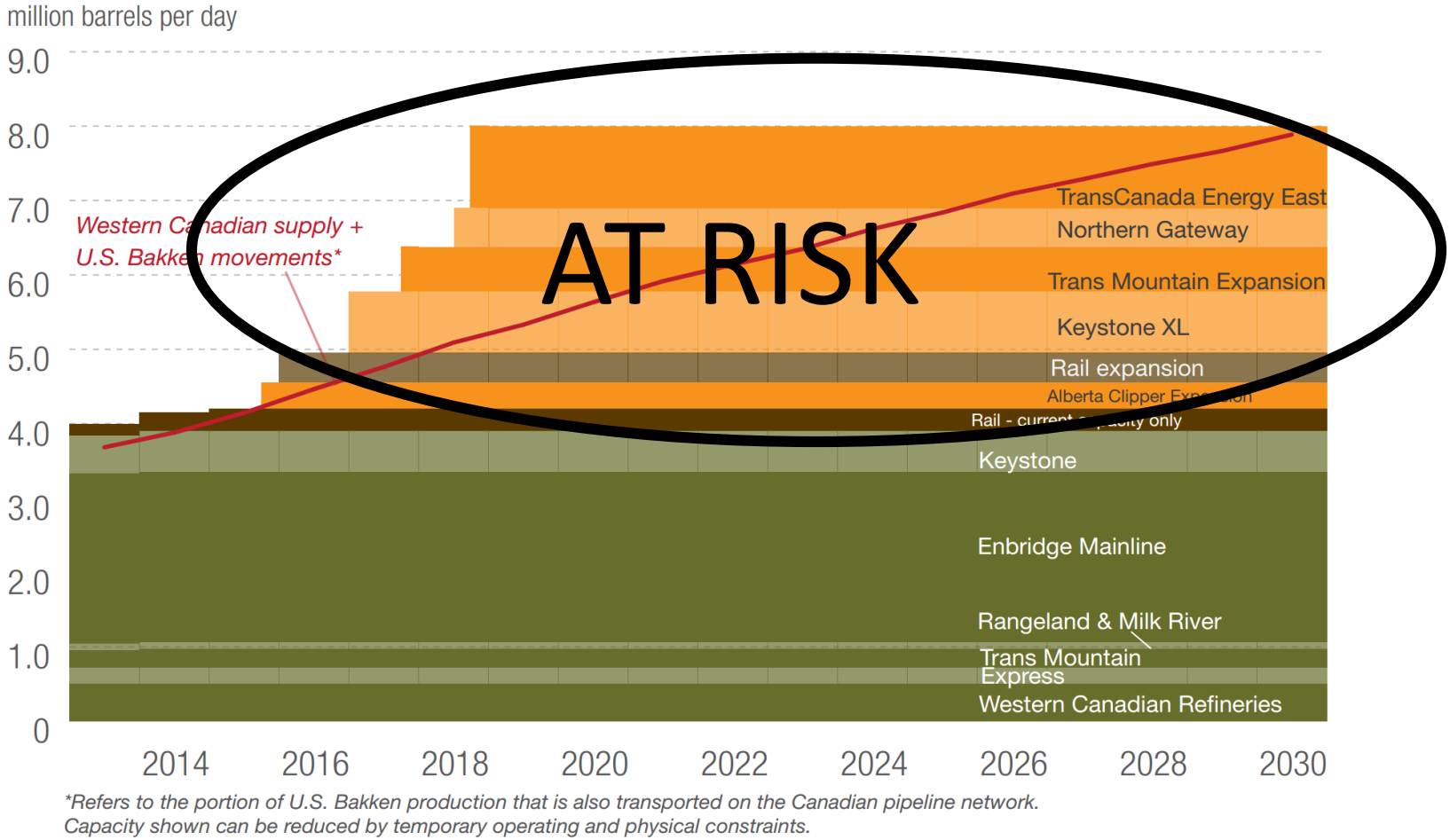
Canadian Crude by Rail Movements





Source: CAPP 2014, "Crude Oil Forecast. Markets, and Transportation"

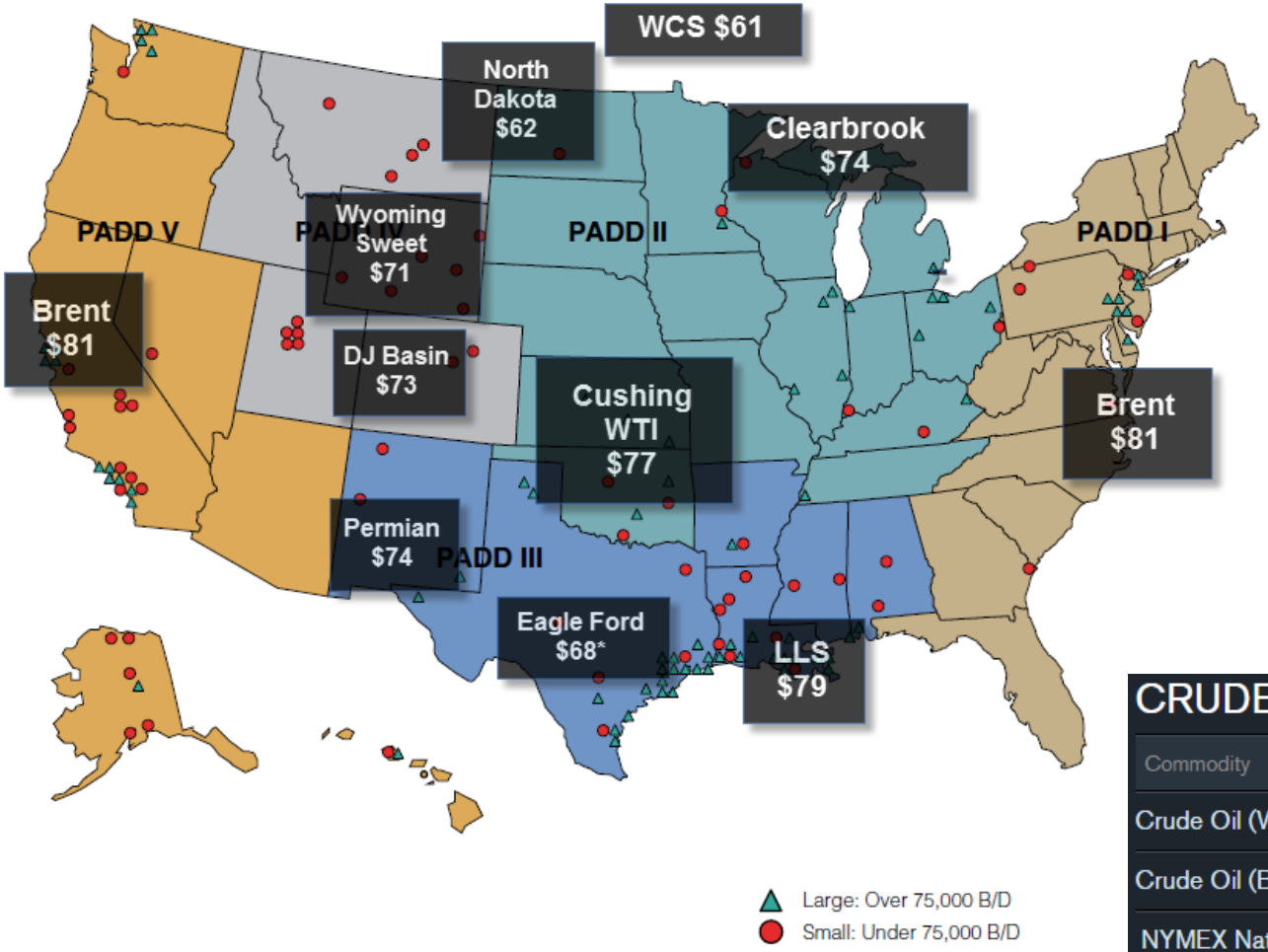
Supply vs. Take-Away Capacity is Risky at Best



*Refers to the portion of U.S. Bakken production that is also transported on the Canadian pipeline network. Capacity shown can be reduced by temporary operating and physical constraints.

Source: CAPP 2014, "Crude Oil Forecast. Markets, and Transportation"

Regional Pricing Disparities

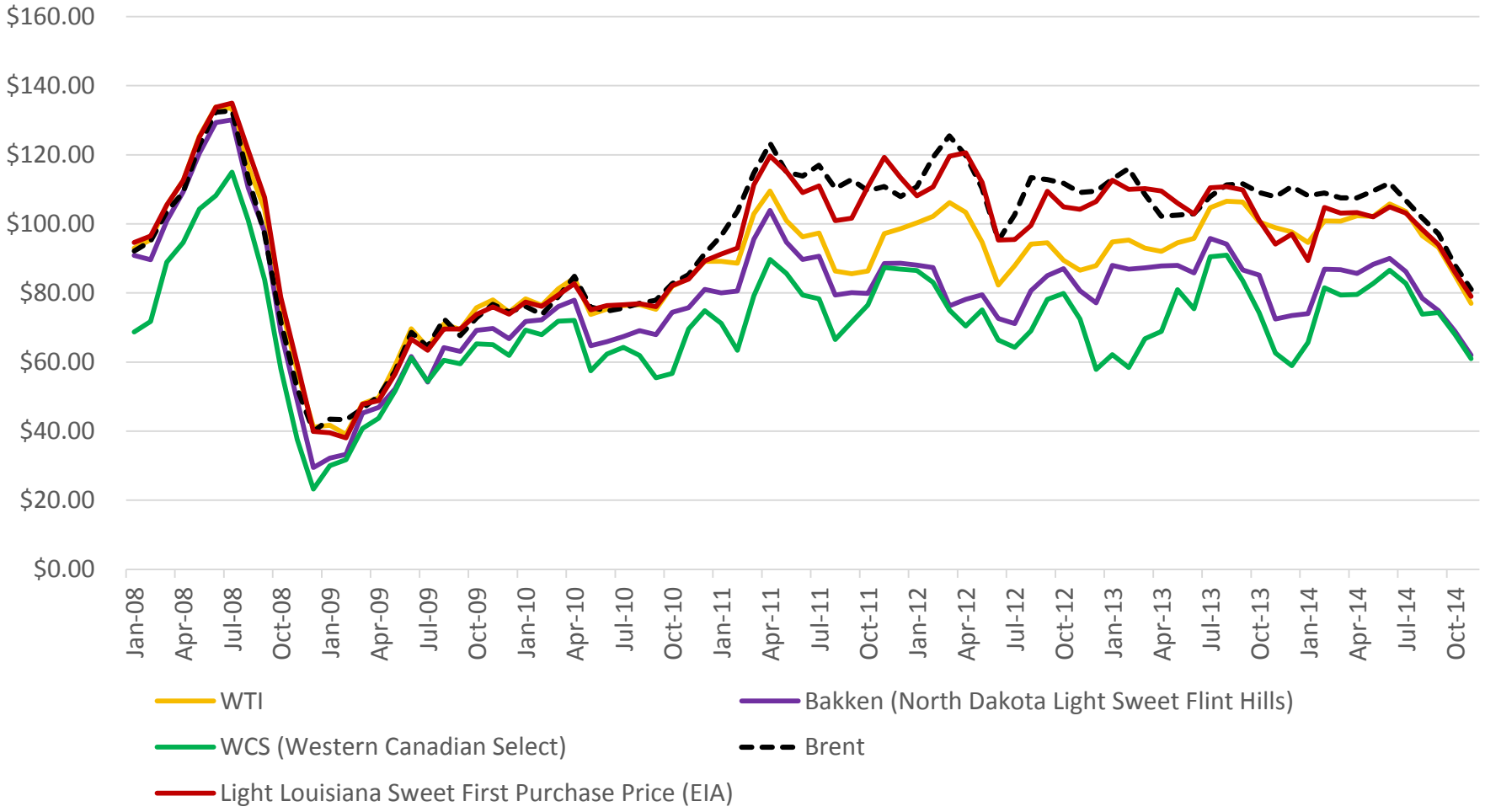


CRUDE OIL & NATURAL GAS

Commodity	Units	Price
Crude Oil (WTI)	USD/bbl.	77.48
Crude Oil (Brent)	USD/bbl.	81.26
NYMEX Natural Gas	USD/MMBtu	4.19

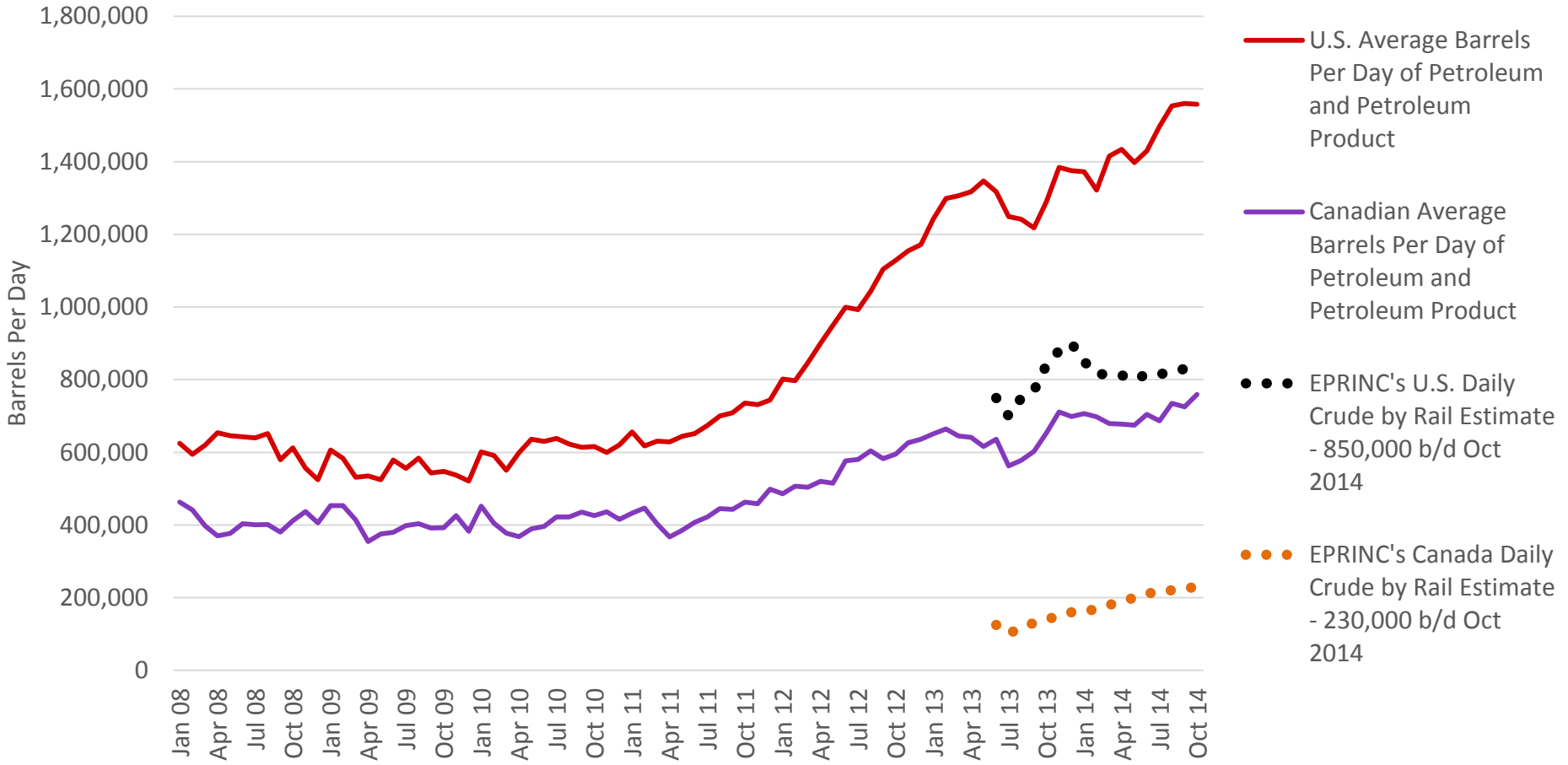
Source: Map from AFPM, Flint Hills, EIA, CME Group, and estimates

Price Comparison



Source: EIA, Flint Hills, CME Group,, Bloomberg

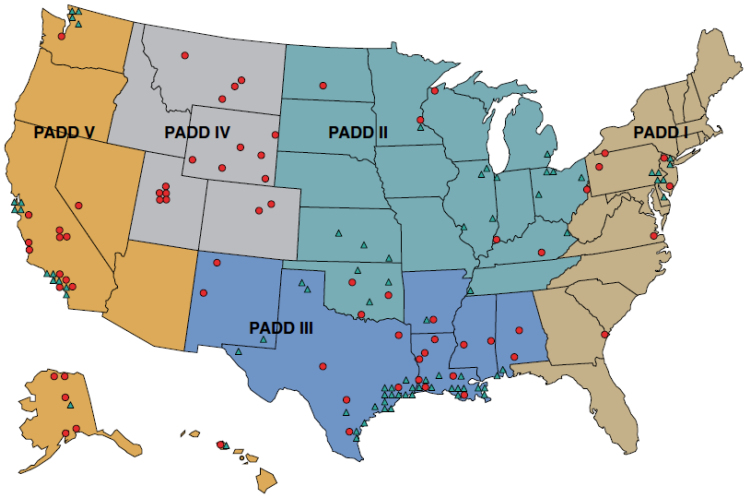
Daily Crude by Rail Shipments in the U.S. and Canada

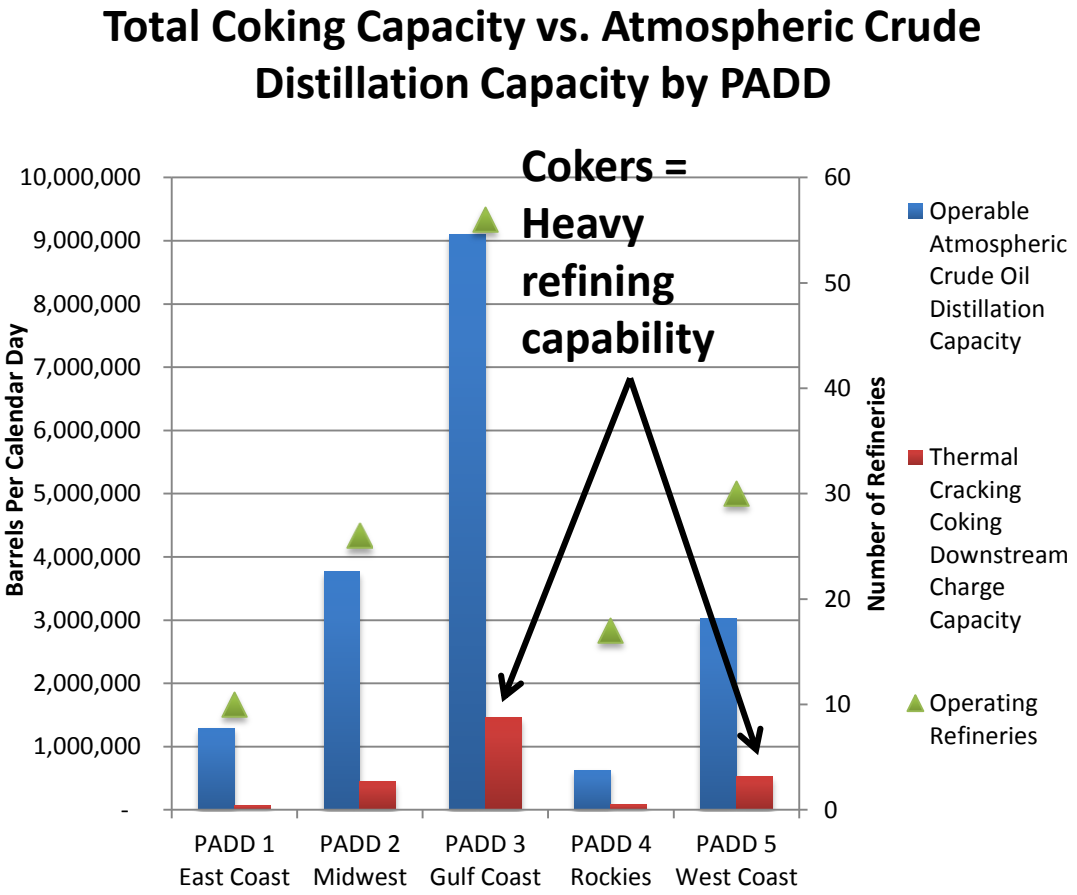


Source: AAR; Crude and petroleum product includes liquefied gases, asphalt, fuel oil, lubricating oil, jet fuel, etc. U.S. operations exclude U.S. operations of CN and CP. Canadian operations include CN and CP and their U.S. operations. One carload holds 30,000 gallons (or 714.3 barrels).

Refineries and all that light sweet crude….

Where the light and heavy need to go….or should go

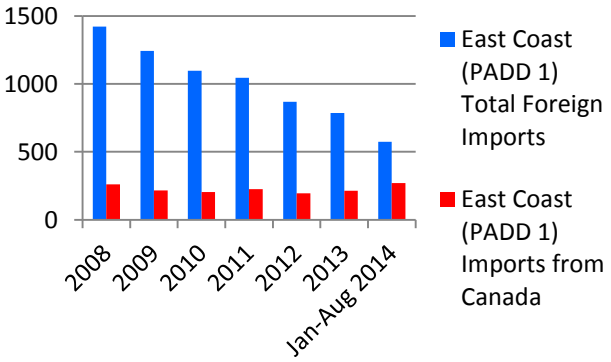




Source: AFPM map, EIA data for graph

Share of Canadian Imports by PADD - RED

PADD I



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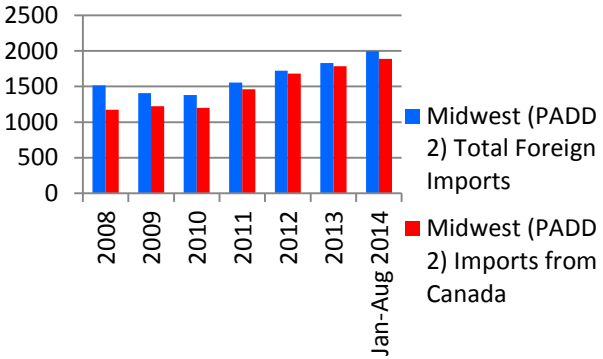
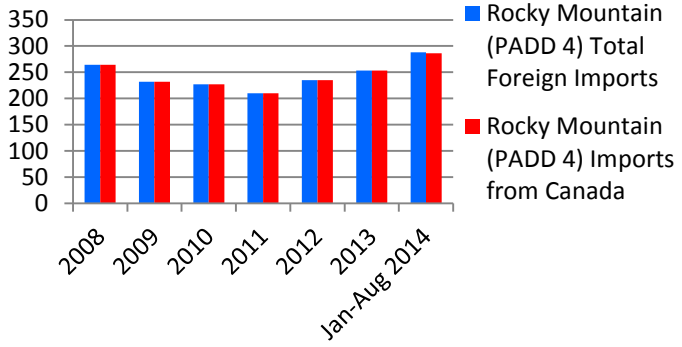
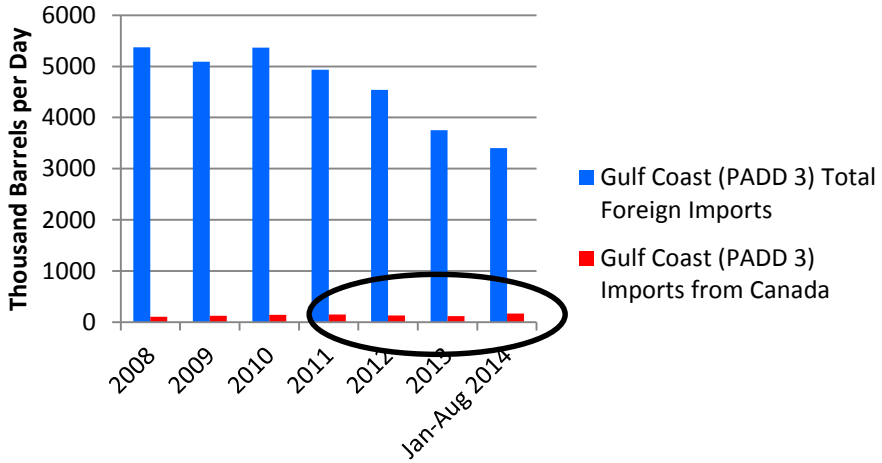


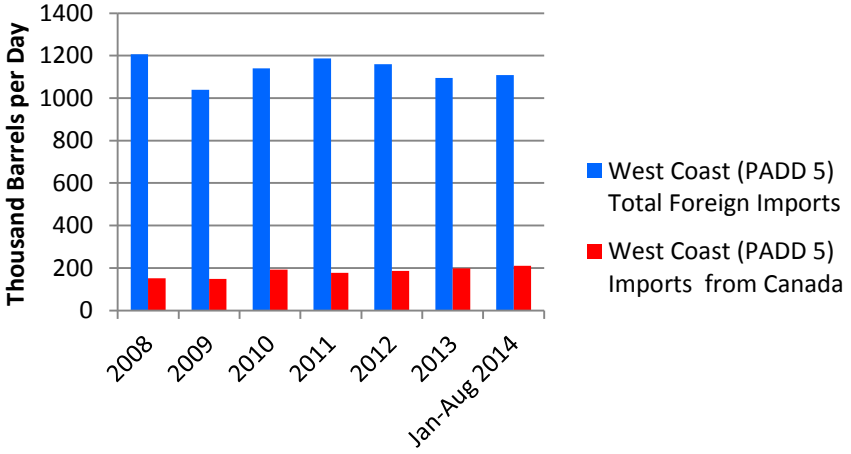
PADD IV



PADD III

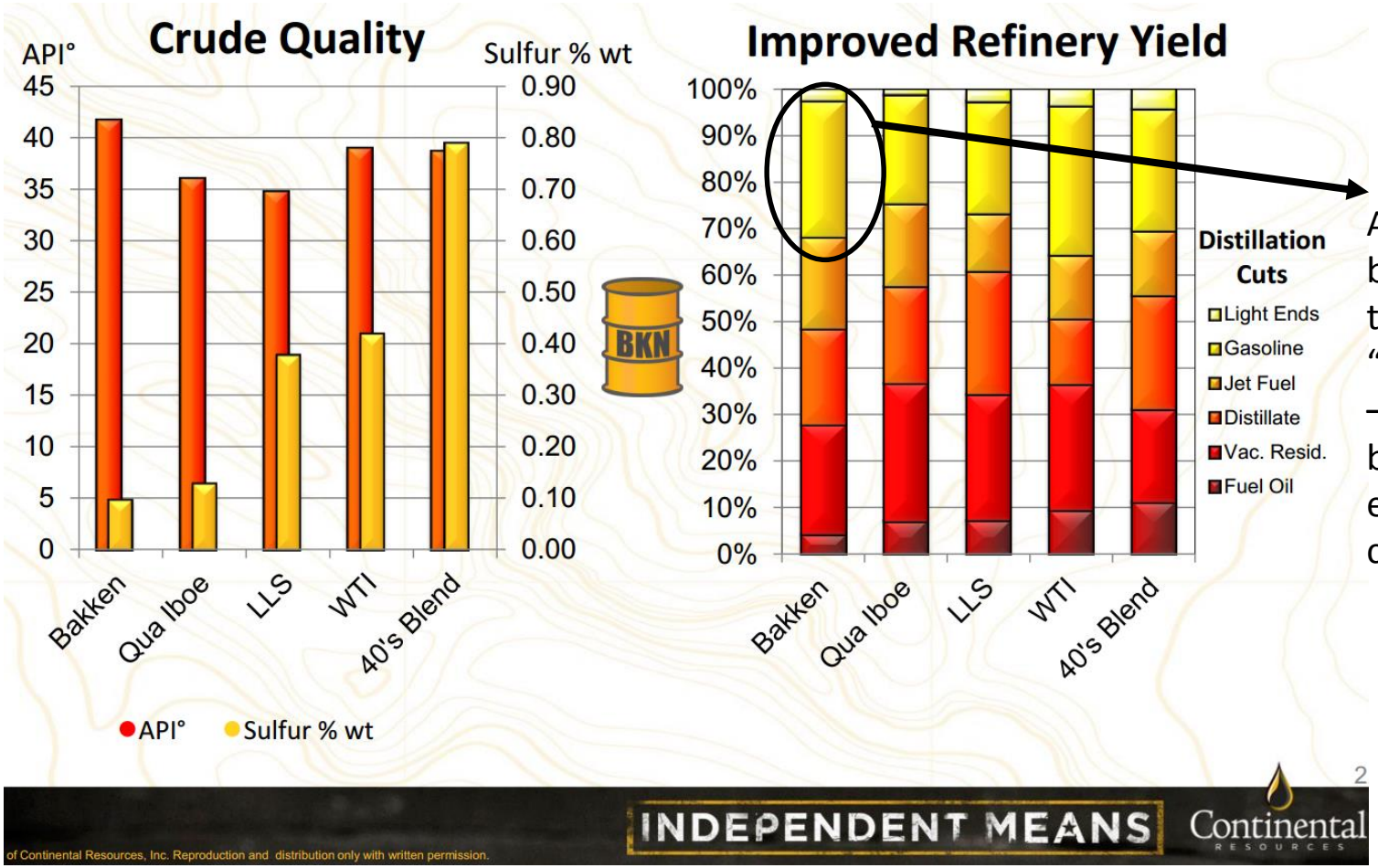


PADD V



Source: EIA Data

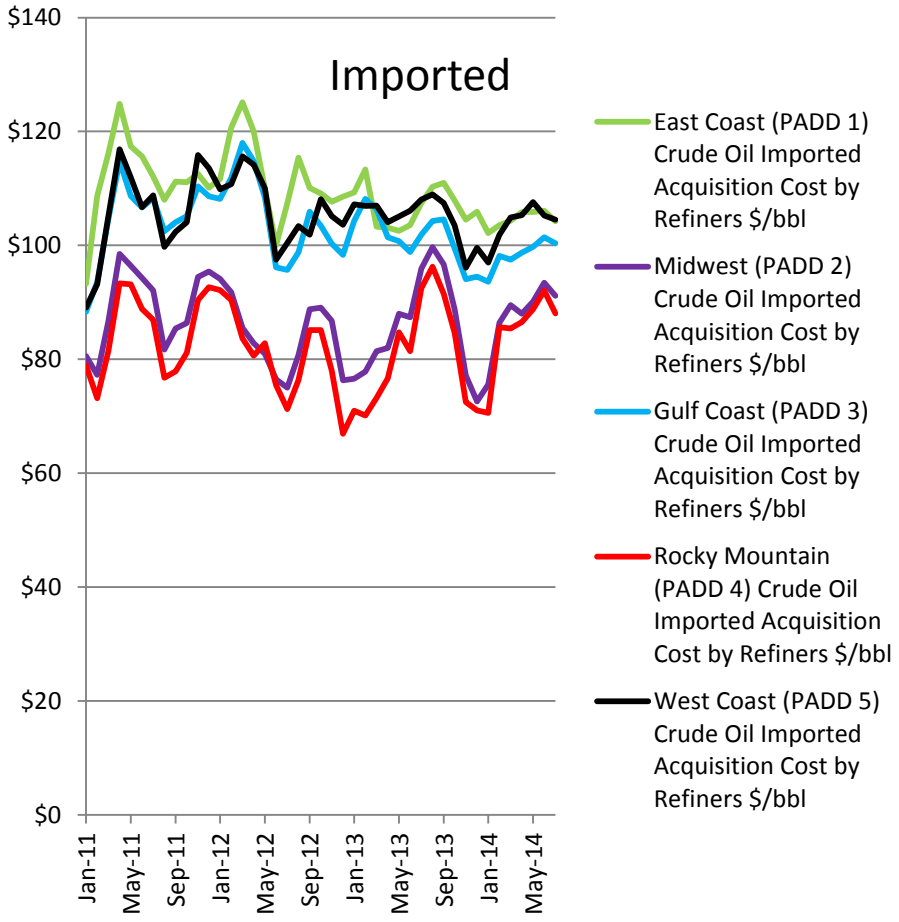
Bakken Quality Comparison

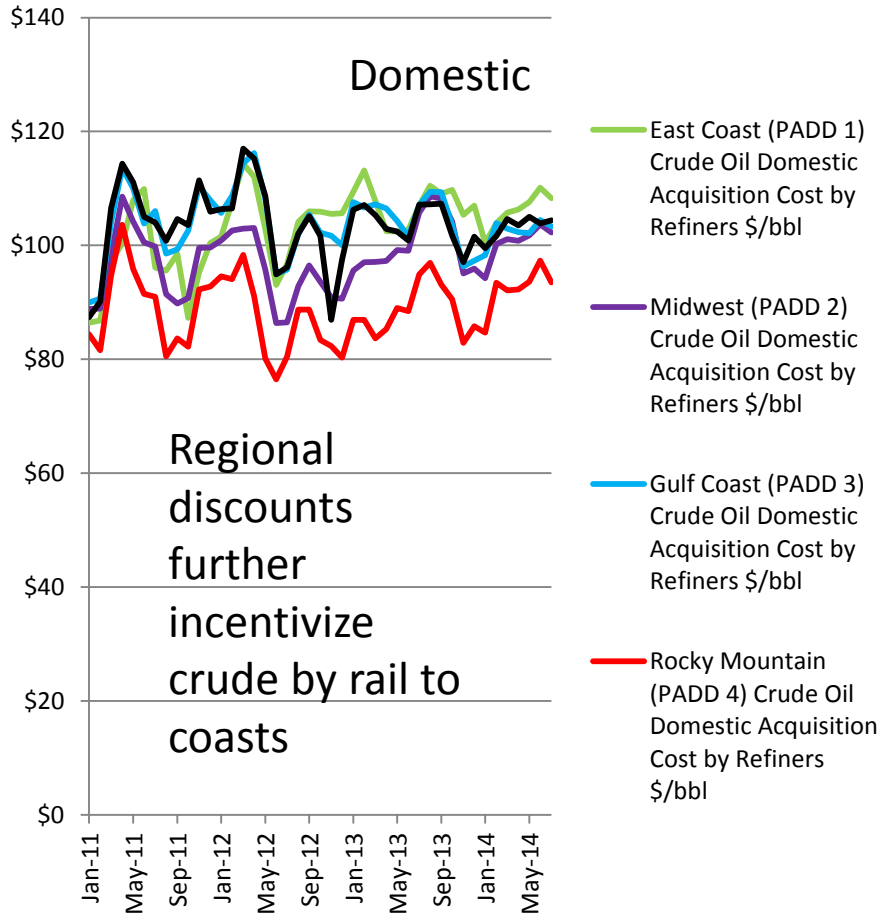


A good barrel, but too many "light ends" – propane, butanes, etc. that can't blend

Source: Continental Resources March Investor Presentation, Permission granted

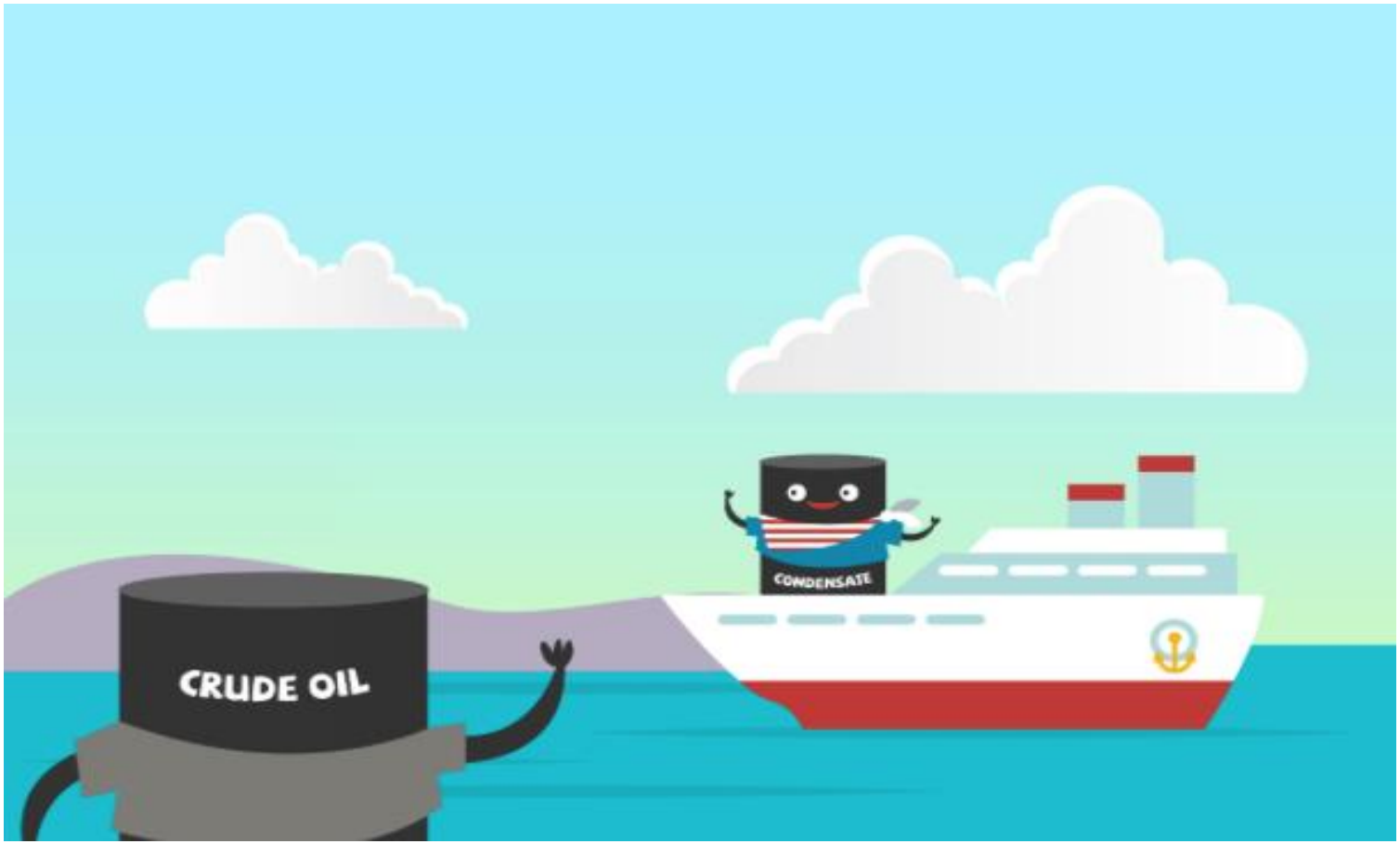
Refinery Acquisition Costs (RAC)





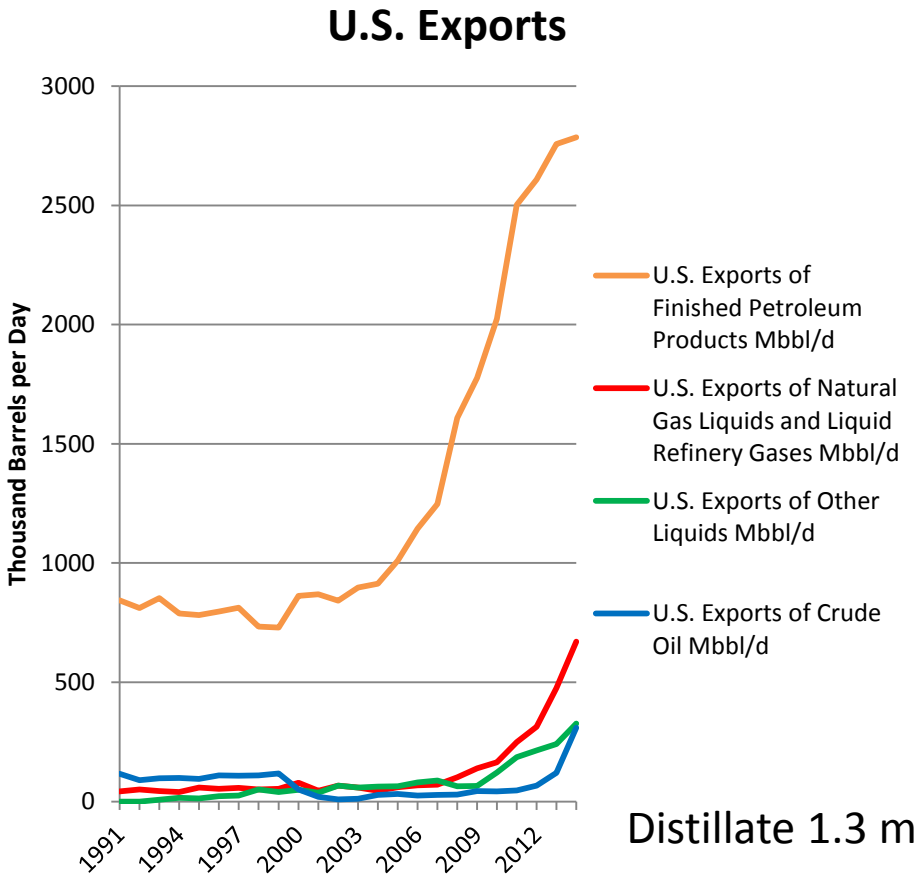
Source: EIA

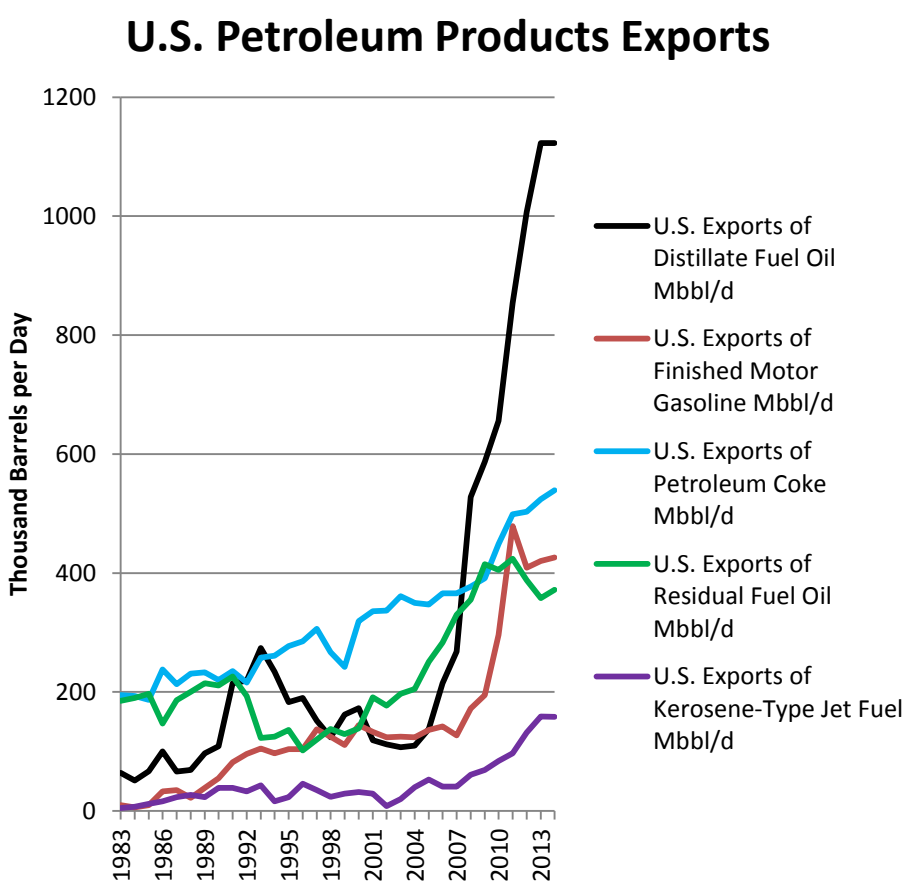
Oil…I mean condensate exports



Source: Drilling Info

U.S. Annual Exports





Distillate 1.3 mbd

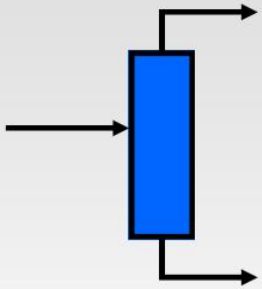
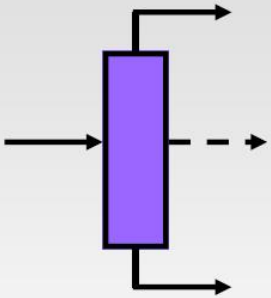
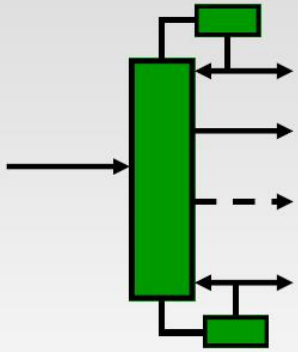
Gasoline 400,000 b/d

Source: EIA

Condensate Processing

Processing Options

Distillation

Field Condensate Stabilizer	USGC Crude Stabilizer	Condensate Splitter
		
Capacity: : ~5 mbbl/day Cap. Cost: ~ Several million $ Op. Cost: $0.50-$1.00/B Construction: ~12 months	Capacity: 100 mbbl/day Cap. Cost: $150 - 200 MM Op. Cost: $0.75-$1.00/B Construction: 12-18 months	Capacity: 100 mbbl/day Cap. Cost: $300-400 MM Op. Cost: $1.00 to $1.50/B Construction: 18-24 months

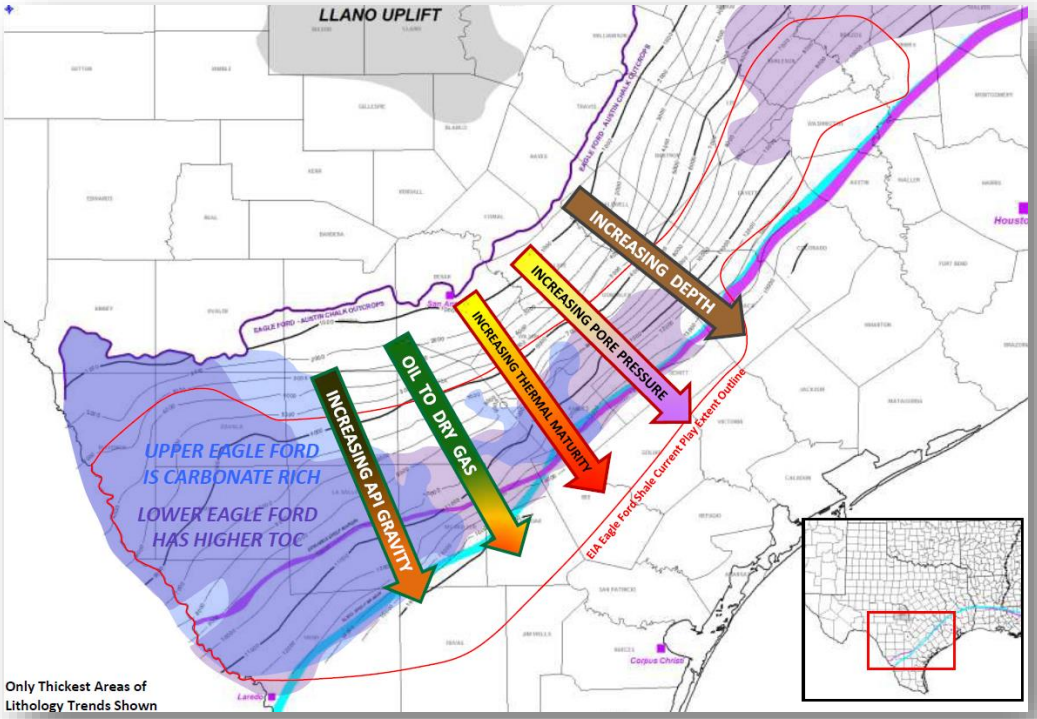
eia

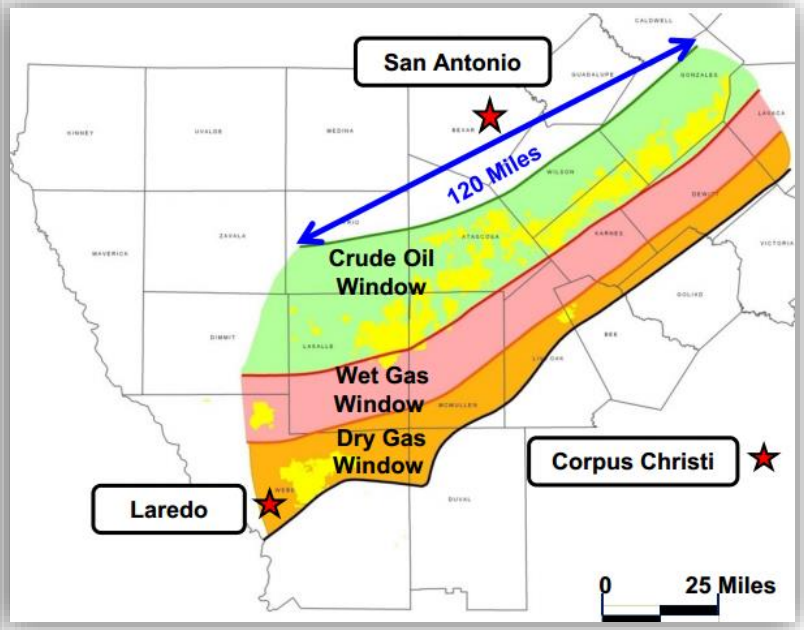
13

Turner, Mason & Company
CONSULTING ENGINEERS

Source: Turner Mason, EIA 2014 Annual DC Conference

Geology of the Eagle Ford = Varying Liquid Grades





Source: Momentum Oil and Gas LLC, DUG Eagle Ford Conference Presentation Oct 2011; EOG Investor Presentation Feb 2014;

These differences have been impacting prices

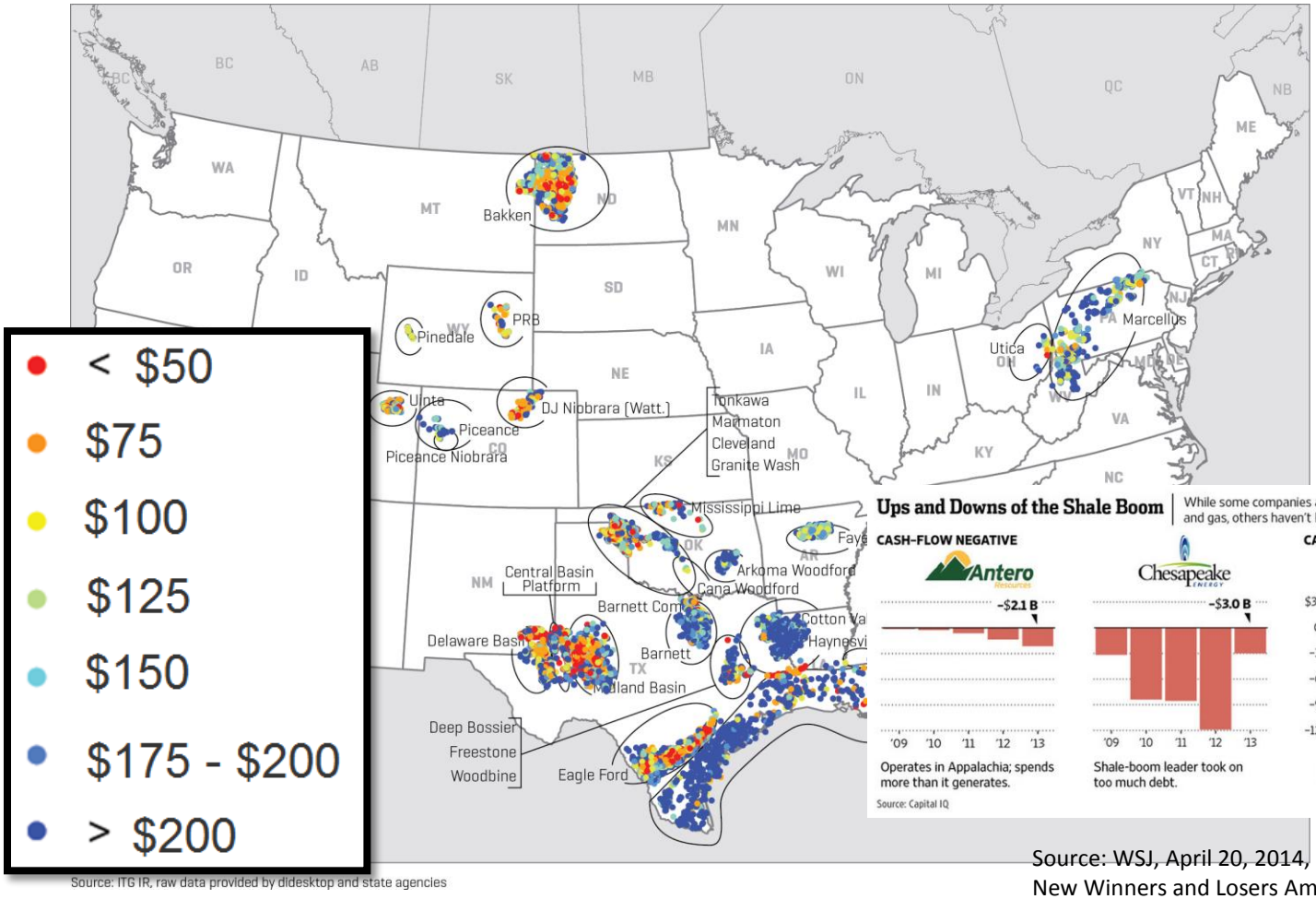
FLINT HILLS RESOURCES CRUDE OIL POSTINGS
P.O. BOX 2917, WICHITA, KS 67201

Effective 7:00 A.M., on dates shown below, and subject to its division orders as amended and supplemented, contracts and other agreements, FLINT HILLS RESOURCES, LP will pay the following prices per barrel of 42 U.S. gallons for merchantable crude oil purchased and delivered into pipelines or facilities authorized by FLINT HILLS RESOURCES, LP, in the fields or area designated below. The following prices are for informational purposes only, do not constitute an offer, and are subject to change or revisions without notice.

Effective Date	11/01/14	11/03/14	11/04/14	11/05/14	11/06/14	11/07/14	11/10/14		09/16/14
Bulletin	20140188	20140189	20140190	20140191	20140192	20140193	20140194	EDQ	20140160
TEXAS									
Eagle Ford Condensate, equal to or greater than 60 API	64.7500	63.0000 *	61.5000 *	63.0000 *	62.2500 *	63.0000 *	61.7500 *		79.7500 *
Eagle Ford Light, equal to or greater than 50 API and less than 60 API	69.7500	70.5000 *	64.0000 *	68.0000 *	67.2500 *	68.0000 *	66.7500 *		84.7500 *
Eagle Ford Sour	68.2500 *	66.5000 *	65.0000 *	66.5000 *	65.7500 *	66.5000 *	65.2500 *		
Eagle Ford West Condensate, equal to or greater than 60 API	64.7500	63.0000 *	61.5000 *	63.0000 *	62.2500 *	63.0000 *	61.7500 *		83.7500 *
Eagle Ford West Light, equal to greater than 50 API and less 60 API	69.7500	70.5000 *	64.0000 *	68.0000 *	67.2500 *	68.0000 *	66.7500 *		86.2500 *
Eagle Ford West Sour	68.2500 *	66.5000 *	65.0000 *	66.5000 *	65.7500 *	66.5000 *	65.2500 *		86.2500 *
Eagle Ford West, crude oil less than 50 API	71.2500	72.0000 *	65.5000 *	69.5000 *	68.7500 *	69.5000 *	68.2500 *		89.2500 *
Eagle Ford, crude oil less than 50 API	71.2500	72.0000 *	65.5000 *	69.5000 *	68.7500 *	69.5000 *	68.2500 *		89.2500 *
Giddings Sweet Texas	75.0000	73.2500 *	71.7500 *	73.2500 *	72.5000 *	73.2500 *	72.0000 *		89.0000 *
Gulf Coast Mix	75.0000	73.2500 *	71.7500 *	73.2500 *	72.5000 *	73.2500 *	72.0000 *		86.2500 *
Pearsall Sweet	74.7500	73.0000 *	71.5000 *	73.0000 *	72.2500 *	73.0000 *	71.7500 *		86.2500 *
South Texas Heavy	71.2500	69.5000 *	68.0000 *	69.5000 *	68.7500 *	69.5000 *	68.2500 *		83.7500 *
South Texas Light Sweet	71.2500	69.5000 *	68.0000 *	69.5000 *	68.7500 *	69.5000 *	68.2500 *		86.2500 *
South Texas Sour	68.2500 *	66.5000 *	65.0000 *	66.5000 *	65.7500 *	66.5000 *	65.2500 *		89.2500 *
South Texas Sweet	71.2500	69.5000 *	68.0000 *	69.5000 *	68.7500 *	69.5000 *	68.2500 *		89.5000 *
South Texas Valley Sweet	75.0000	73.2500 *	71.7500 *	73.2500 *	72.5000 *	73.2500 *	72.0000 *		91.2500 *
Upper Texas Gulf Coast	75.2500	73.5000 *	72.0000 *	73.5000 *	72.7500 *	73.5000 *	72.2500 *		
West Texas/New Mexico Intermediate	77.0000	75.2500 *	73.7500 *	75.2500 *	74.5000 *	75.2500 *	74.0000 *		

Nov 11th, 2014
WTI $77
Brent $81
Nat Gas $4.25

Regional Discounts Matter with High Cost Production



Source: ITG Investment Presentation Nov 2012

Source: WSJ, April 20, 2014, Russel Gold Theo Francis "The New Winners and Losers America's Shale Boom"

Accidents and Regulations

Recent Crude by Rail Accidents

- July 6, 2013, a run-away train crashed and exploded in Lac-Mégantic, Quebec, killing 47 people and destroying parts of the town
- November 8, 2013, about 12 cars derailed in a unit train of 90 cars carrying crude oil near Aliceville, Alabama (45 miles SW Tuscaloosa). Nobody was injured, but three of the cars exploded.
- December 30, 2013, a train hauling grain derailed near Casselton,(SE) ND hitting a 106 car unit train of crude oil which caused 18 crude tank cars to derail causing a massive explosion and fireball
- January 7, 2014, a Canadian National train jumped tracks in Plaster Rock, New Brunswick. 15 cars derailed and caught fire. The train was carrying propane and crude oil from Western Canada
- January 20, 2014, a CSX train derailed in Pennsylvania on a railroad bridge and close a busy expressway (Schuylkill), but did not leak any crude oil.
- April 30, 2014, oil tanks cars on CSX derailed and caught fire in Lynchburg, VA (3 of 15 cars that derailed caught fire). Nobody was injured by 300 people were evacuated temporarily

Table 3—Major Crude Oil/Ethanol Train Accidents in the U.S.

Location	Date(MM/YY)	Numberof tank cars derailed	Number ofcrude oil/ethanol carspenetrated	Speed atderailment in miles per hour(mph)	Materialand typeof train	Productloss(gallonsof crudeorethanol)	Fire	Type of train accident or cause of train accident
LaSalle, CO	05/14	5	1	9	Crude Oil(unit)	5,000	No	To Be Determined (TBD).
Lynchburg, VA	04/14	17	2	23	Crude Oil(unit)	30,000	Yes	TBD.
Vandergrift, PA	02/14	21	4	31	Crude Oil	10,000	No	TBD.
New Augusta, MS	01/14	26	25	45	Crude Oil	90,000	No	TBD.
Casselton, ND	12/13	20	18	42	Crude Oil(unit)	476,436	Yes	Collision.
Aliceville, AL	11/13	26	25	39	Crude Oil(unit)	630,000	Yes	TBD.
Plevna, MT	08/12	17	12	25	Ethanol	245,336	Yes	TBD.
Columbus, OH	07/12	3	3	23	Ethanol	53,347	Yes	TBD—NTSB Investigation.
Tiskilwa, IL	10/11	10	10	34	Ethanol	143,534	Yes	TBD—NTSB Investigation.
Arcadia, OH	02/11	31	31	46	Ethanol(unit)	834,840	Yes	Rail Defect.
Rockford/Cherry Valley, IL	06/09	19	13	19	Ethanol(unit)	232,963	Yes	Washout.
Painesville, OH	10/07	7	5	48	Ethanol	76,153	Yes	Rail Defect.
New Brighton, PA	10/06	23	20	37	Ethanol(unit)	485,278	Yes	Rail Defect.

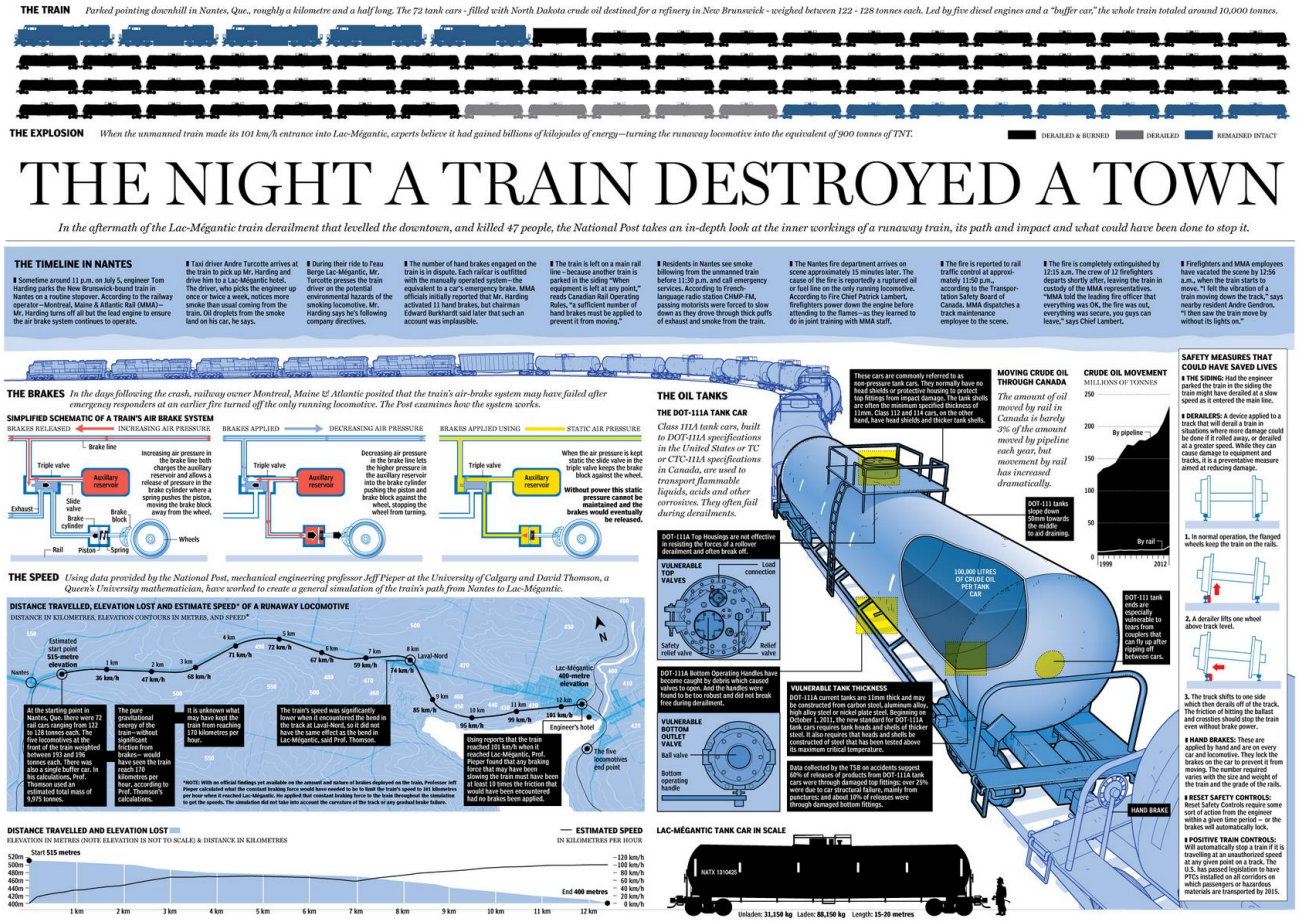
Source: PHMSA proposed rules; http://www.regulations.gov/#!documentDetail;D=PHMSA-2012-0082-0180

Crude by Rail Accidents

LAC MAGENTIC: AP PHOTO/THE CANADIAN PRESS, PAUL CHIASSON

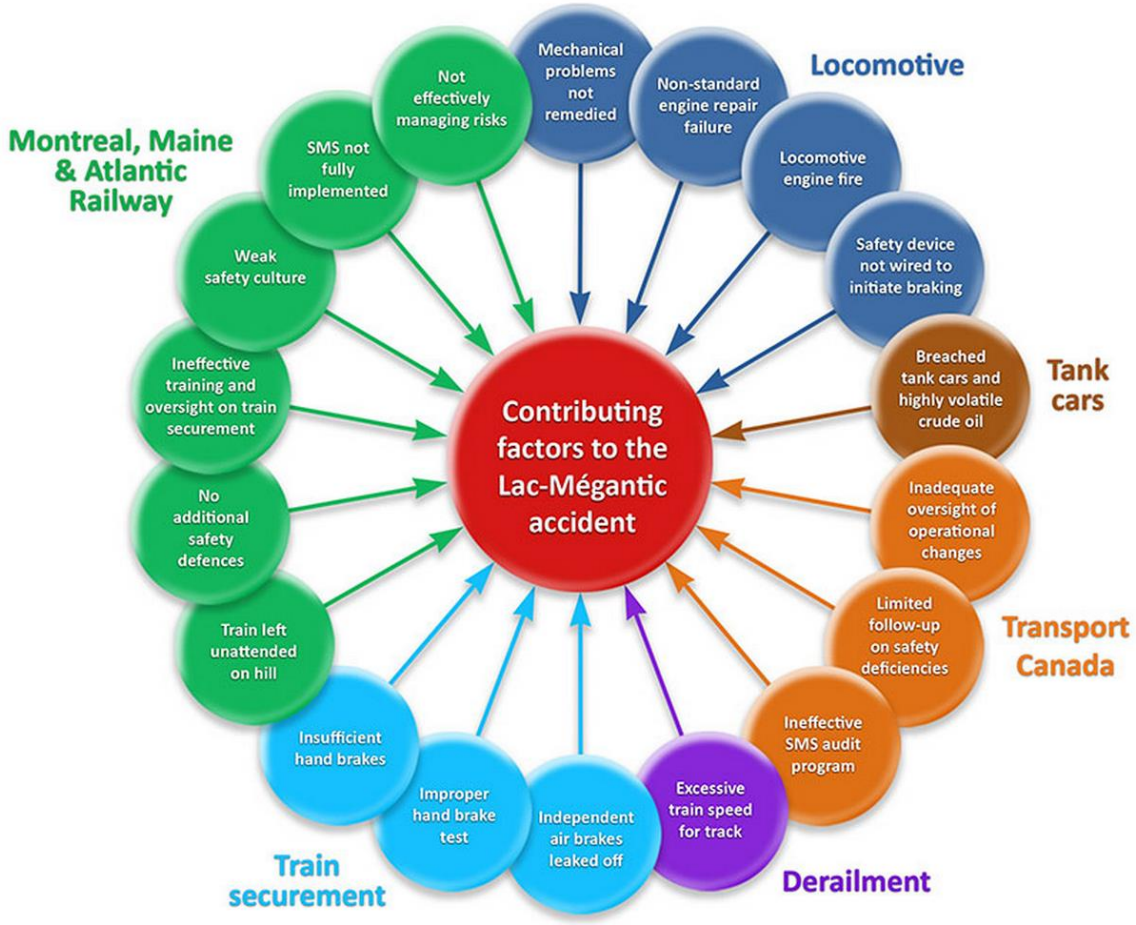
http://usnews.nbcnews.com/_news/2013/12/30/22113442-mile-long-train-carrying-crude-oil-derails-explodes-in-north-dakota?lite

Lac Magentic Crude by Rail Accident



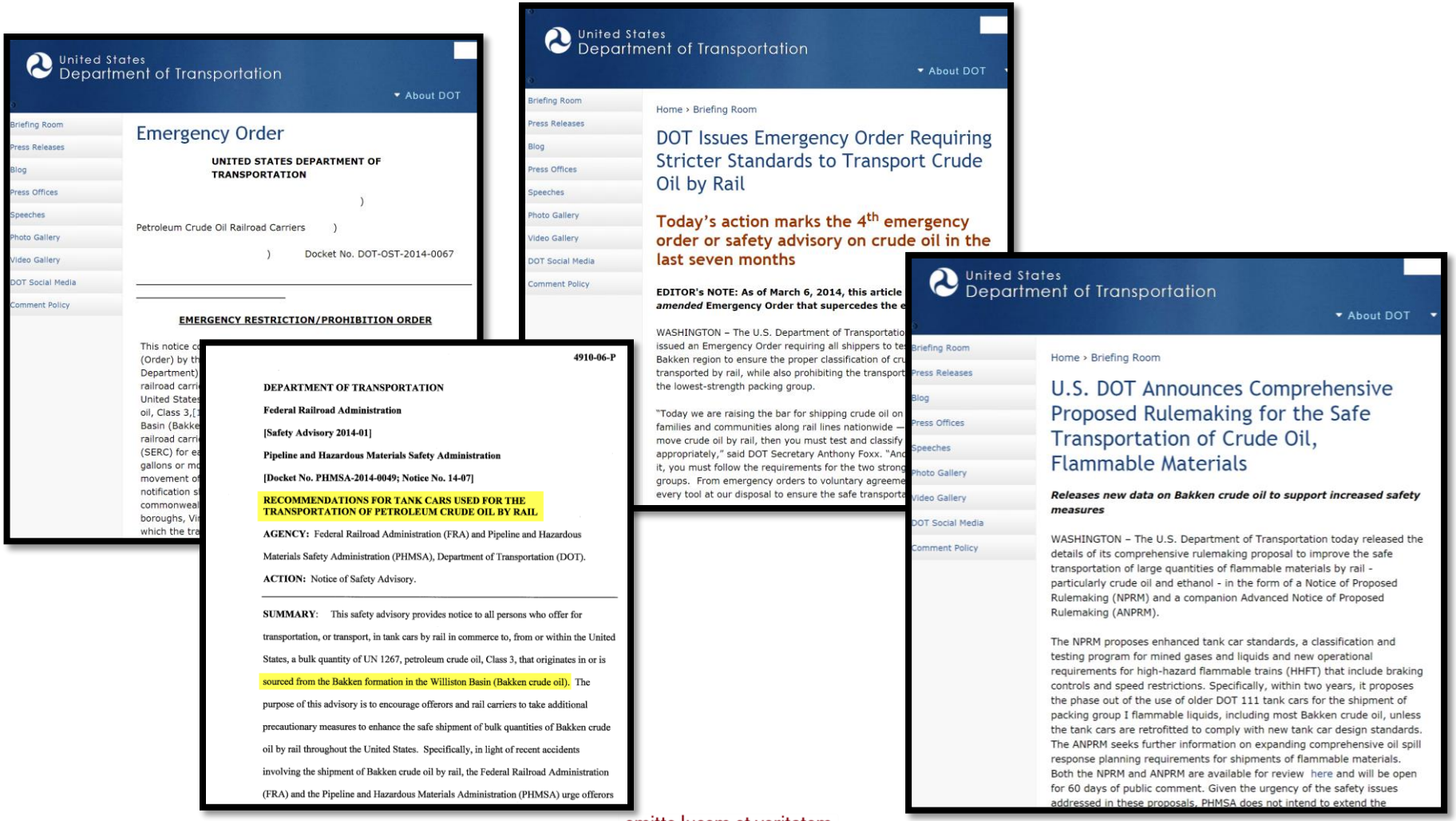
SOURCE: NATIONAL POST, JAKE EDMISTON AND ANDREW BARR, MIKE FAILLE, JONATHAN RIVAIT, RICHARD JOHNSON | July 12, 2013 | Last Updated: Aug 7 5:36 PM ET

Canadian TSB finds 18 causes and contributing factors



Source: TSB, http://www.tsb.gc.ca/eng/rapports-reports/rail/2013/r13d0054/r13d0054-r-es.asp

Emergency Orders and Recommendations beginning May 2014



United States Department of Transportation

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Emergency Order

UNITED STATES DEPARTMENT OF TRANSPORTATION

Petroleum Crude Oil Railroad Carriers)

) Docket No. DOT-OST-2014-0067

EMERGENCY RESTRICTION/PROHIBITION ORDER

United States Department of Transportation

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DOT Issues Emergency Order Requiring Stricter Standards to Transport Crude Oil by Rail

Today's action marks the 4th emergency order or safety advisory on crude oil in the last seven months

EDITOR's NOTE: As of March 6, 2014, this article
***amended* Emergency Order that supercedes the e**

WASHINGTON – The U.S. Department of Transportatio
issued an Emergency Order requiring all shippers to te
Bakken region to ensure the proper classification of cru
transported by rail, while also prohibiting the transport
the lowest-strength packing group.

"Today we are raising the bar for shipping crude oil on
families and communities along rail lines nationwide —
move crude oil by rail, then you must test and classify
appropriately," said DOT Secretary Anthony Foxx. "And
it, you must follow the requirements for the two strong
groups. From emergency orders to voluntary agreeme
every tool at our disposal to ensure the safe transporta

4910-06-P

DEPARTMENT OF TRANSPORTATION

Federal Railroad Administration

[Safety Advisory 2014-01]

Pipeline and Hazardous Materials Safety Administration

[Docket No. PHMSA-2014-0049; Notice No. 14-07]

RECOMMENDATIONS FOR TANK CARS USED FOR THE TRANSPORTATION OF PETROLEUM CRUDE OIL BY RAIL

AGENCY: Federal Railroad Administration (FRA) and Pipeline and Hazardous Materials Safety Administration (PHMSA), Department of Transportation (DOT).

ACTION: Notice of Safety Advisory.

SUMMARY: This safety advisory provides notice to all persons who offer for transportation, or transport, in tank cars by rail in commerce to, from or within the United States, a bulk quantity of UN 1267, petroleum crude oil, Class 3, that originates in or is sourced from the Bakken formation in the Williston Basin (Bakken crude oil). The purpose of this advisory is to encourage offerors and rail carriers to take additional precautionary measures to enhance the safe shipment of bulk quantities of Bakken crude oil by rail throughout the United States. Specifically, in light of recent accidents involving the shipment of Bakken crude oil by rail, the Federal Railroad Administration (FRA) and the Pipeline and Hazardous Materials Administration (PHMSA) urge offerors

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U.S. DOT Announces Comprehensive Proposed Rulemaking for the Safe Transportation of Crude Oil, Flammable Materials

Releases new data on Bakken crude oil to support increased safety measures

WASHINGTON – The U.S. Department of Transportation today released the details of its comprehensive rulemaking proposal to improve the safe transportation of large quantities of flammable materials by rail - particularly crude oil and ethanol - in the form of a Notice of Proposed Rulemaking (NPRM) and a companion Advanced Notice of Proposed Rulemaking (ANPRM).

The NPRM proposes enhanced tank car standards, a classification and testing program for mined gases and liquids and new operational requirements for high-hazard flammable trains (HHFT) that include braking controls and speed restrictions. Specifically, within two years, it proposes the phase out of the use of older DOT 111 tank cars for the shipment of packing group I flammable liquids, including most Bakken crude oil, unless the tank cars are retrofitted to comply with new tank car design standards. The ANPRM seeks further information on expanding comprehensive oil spill response planning requirements for shipments of flammable materials. Both the NPRM and ANPRM are available for review here and will be open for 60 days of public comment. Given the urgency of the safety issues addressed in these proposals, PHMSA does not intend to extend the

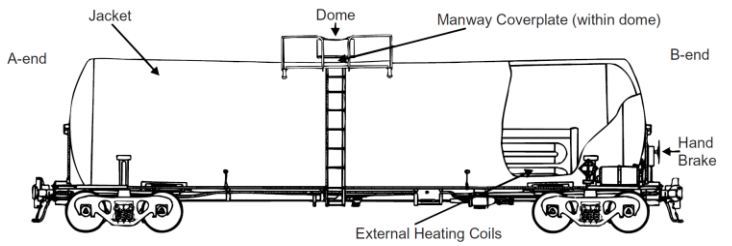
Comprehensive Regulation Proposals by PHMSA

Table 4—Rulemaking Provisions and Safety Justifications

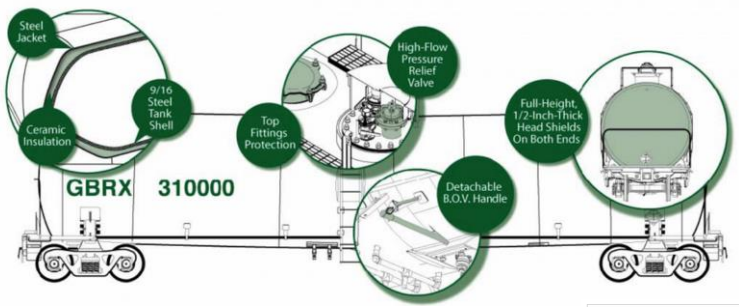
Provision	Justification
Rail Routing	PHMSA is proposing routing requirements to reduce the risk of a train accident. This proposal requires railroads to balance the risk factors to identify the route that poses the lower risk. As such, they may, in certain cases, choose a route that eliminates exposure in areas with high population densities but poses a risk for more frequent events in areas with very low densities. In other cases the risk of derailment may be so low along a section of track that, even though it runs through a densely populated area, it poses the lowest total risk when severity and likelihood are considered.
Classification of Mined Gas and Liquid	PHMSA is proposing to require a sampling and testing program for mined gas and liquid, such as crude oil. PHMSA expects the proposed requirements would reduce the expected non-catastrophic damages and ensure that materials are properly classified in accordance with the HMR.
Notification to SERCs	PHMSA is proposing to codify the May 7, 2014, DOT issued an Emergency Restriction/Prohibition Order in Docket No. DOT-OST-2014-0067 (EO or Order). Recent accidents have demonstrated the need for action in the form of additional communication between railroads and emergency responders to ensure that the emergency responders are aware of train movements carrying large quantities of crude oil through their communities.
Speed Restrictions	PHMSA is proposing to restrict the speed of HHFTs. Speed is a factor that may contribute to derailments. Speed can influence the probability of an accident, as lower speeds may allow for a brake application to stop the train before a collision. Speed also increases the kinetic energy of a train, resulting in a greater possibility of the tank cars being punctured in the event of a derailment. The proposed restrictions will reduce the frequency and severity of train accidents.
Braking	To reduce the number of cars and energy associated with train accidents, PHMSA is proposing to require alternative brake signal propagation systems: Distributed power (DP), or two-way end of train devices (EOT); for tank car Option 1, electronic controlled pneumatic brakes (ECP)
Tank Car Specifications	PHMSA is proposing a new DOT Specification 117 tank car to address the risks associated with the rail transportation of ethanol and crude oil and the risks posed by HHFTs. All tank car Options for the DOT Specification 117 incorporate several enhancements to increase puncture resistance; provide thermal protection to survive a 100-minute pool fire; and protect top fitting (new construction only) and bottom outlets during a derailment. Under all Options, the proposed system of design enhancements would reduce the consequences of a derailment of tank cars carrying crude oil or ethanol. There would be fewer car punctures, fewer releases from the service equipment (top and bottom fittings), and delayed release of flammable liquid from the tank cars through the pressure relief devices.

Source: PHMSA proposed rules; http://www.regulations.gov/#!documentDetail;D=PHMSA-2012-0082-0180

The Tank Car



Source: DOT 111, Wikipedia



Source: "Tank Car of the Future," Greenbrier presentation via RBN Energy

- Regulations designed to retrofit older DOT 111 tank cars and set standards for new tank cars, but specification and retrofitting requirements have yet to be implemented/determined.
- Some tank car manufacturing companies have moved ahead in anticipation of regs and are building higher strength tank cars above expected regulations.

Tank car	Bottom outlet handle	GRL(lbs)	Head shield type	Pressure relief valve	Shell thickness	Jacket	Tank material *	Top fittingsprotection **	Thermalprotectionsystem	Braking
Option 1: PHMSA and FRA Designed Tank Car	Bottom outlet handle removed or designed to prevent unintended actuation during a train accident	286k	Full-height,1/2inch thick head shield	Reclosing pressure relief device	9/16inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight	TC-128 Grade B, normalized steel	TIH Top fittings protection system and nozzle capable of sustaining, without failure, a rollover accident at a speed of 9 mph	Thermal protection system in accordance with § 179.18	ECP brakes.
Option 2: AAR 2014 Tank Car	Bottom outlet handle removed or designed to prevent unintended actuation during a train accident	286k	Full-height,1/2inch thick head shield	Reclosing pressure relief device	9/16inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight	TC-128 Grade B, normalized steel	Equipped per AAR Specifications Tank Cars, appendix E paragraph 10.2.1	Thermal protection system in accordance with § 179.18	In trains with DP or EOT devices.
Option 3: Enhanced CPC 1232 Tank Car	Bottom outlet handle removed or designed to prevent unintended actuation during a train accident	286k	Full Height1/2inch thick head shield	Reclosing pressure relief device	7/16inch Minimum	Minimum 11-gauge jacket constructed from A1011 steel or equivalent. The jacket must be weather-tight	TC-128 Grade B, normalized steel	Equipped per AAR Specifications Tank Cars, appendix E paragraph 10.2.1	Thermal protection system in accordance with § 179.18	In trains with DP or EOT devices.
DOT 111A100W1Specification (Currently Authorized)	Bottom Outlets are Optional	263K	Optional; Bare Tanks half height; Jacket Tanks full height	Reclosing pressure relief valve	7/16inch Minimum	Jackets are optional	TC-128 Grade B, normalized steel. *	Not required, but when Equipped per AAR Specifications Tank Cars, appendix E paragraph 10.2.1	Optional	Not required.

Source: PHMSA proposed rules; http://www.regulations.gov/#!documentDetail;D=PHMSA-2012-0082-0180

How many tank cars?

Tank car category	Population
Total # of Tank Cars	334,869
Total # of DOT 111	272,119
Total # of DOT 111 in Flammable Liquid Service	80,500
Total # of CPC 1232 in Flammable Liquid Service	17,300
Total # of Tank Cars hauling Crude Oil	42,550
Total # of Tank Cars Hauling Ethanol	29,780
CPC 1232 (Jacketed) in Crude Oil Service	4,850
CPC 1232 (Jacketed) in Ethanol Service	0
CPC 1232 (Non-Jacketed) in Crude Oil Service	9,400
CPC 1232 (Non-Jacketed) in Ethanol Service	480
DOT 111 (Jacketed) in Crude Oil Service	5,500
DOT 111 (Jacketed) in Ethanol Service	100
DOT 111 (Non-Jacketed) in Crude Oil Service	22,800
DOT 111 (Non-Jacketed) in Ethanol Service	29,200

Source: PHMSA proposed rules; http://www.regulations.gov/#!documentDetail;D=PHMSA-2012-0082-0180

Many Entities Involved

Issues

- labeling
- volatility
- rail safety
- tank car strength

Groups Involved

- producers
- truckers
- shippers
- marketers
- refineries
- railroads
- tank car manufacturers

Not necessarily on the same page

THE WALL STREET JOURNAL.

U.S. NEWS

Bakken Crude Is Highly Volatile, Oil Study Shows

Data Released by Refiners Group Confirm Earlier Findings on Petroleum From Shale Deposit

By LYNN COOK

May 14, 2014 7:56 p.m. ET

Instead, attention should shift to the rail industry's safety record, said Charles Drevna, president of the oil-refiner trade group, some of whose members have made big investments in crude-by-rail infrastructure such as tank cars. "The debate should now focus on the remaining issues—track integrity and maintenance and training for rail operators and responders," Mr. Drevna said."

Rail executives, including Mr. Harrison, have criticized the moves, warning that such regulation could prove costly and onerous. "Those bureaucrats have no transportation experience," he said, adding that reducing speed further for all cargo, including crude and other hazardous materials, as has been proposed, would be a "nightmare" for the railroad.

WSJ, "CP's Boss: A Too-Tough Love?," David George-Cosh, May 13, 2014

"Kari Cutting, vice president of the North Dakota Petroleum Council, said she didn't know what had changed since her group met with PHMSA last week…'Our Bakken characterization study is not indicating that Bakken crude oil is more hazardous than other crude oil, and we're thinking that Bakken crude oil is being singled out for political reasons,' Cutting said in an interview yesterday.

EEnews, "DOT crude by rail orders close in on Bakken oil," May 8 2014

THE WALL STREET JOURNAL.

U.S. NEWS

U.S. Transportation Dept. Says Energy Companies Not Sharing Test Data on Bakken Oil

Government Is Seeking Data on the Crude After a Series of Railroad Accidents in Which Oil Exploded

By RUSSELL GOLD

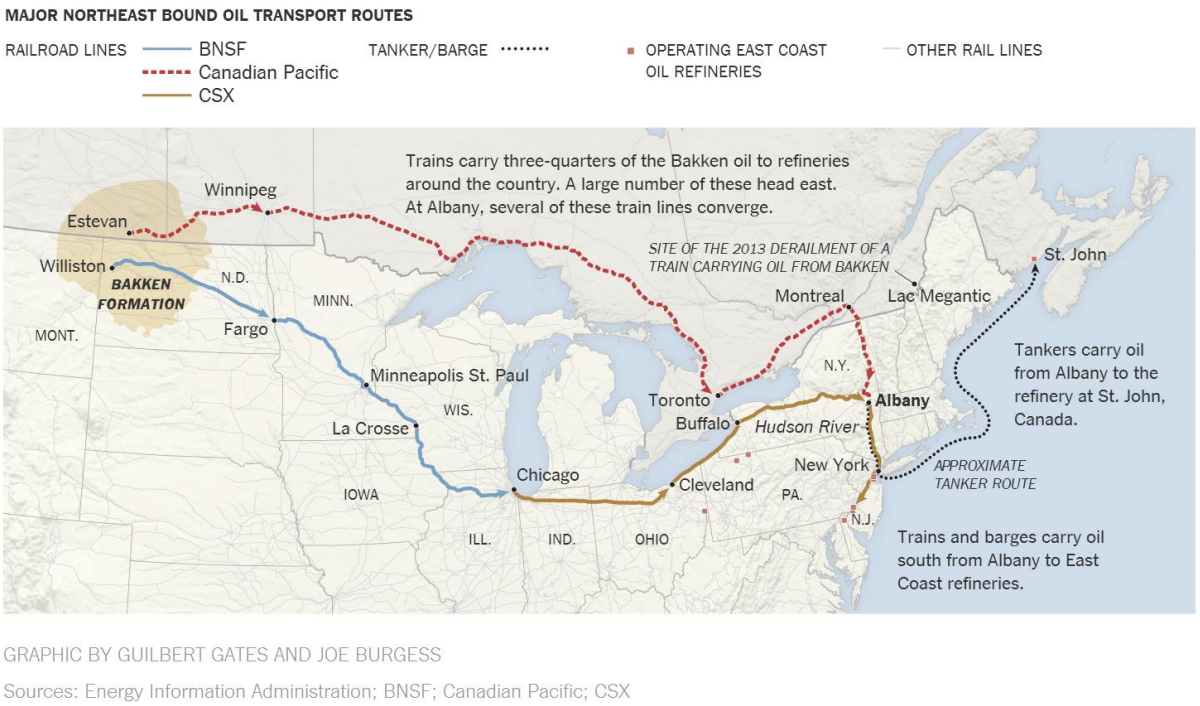
Updated May 2, 2014 5:10 p.m. ET

New York Moratorium

- NY's Albany County placed a moratorium on crude oil processing expansions in the Port of Albany until health investigations and environmental impacts could be assessed

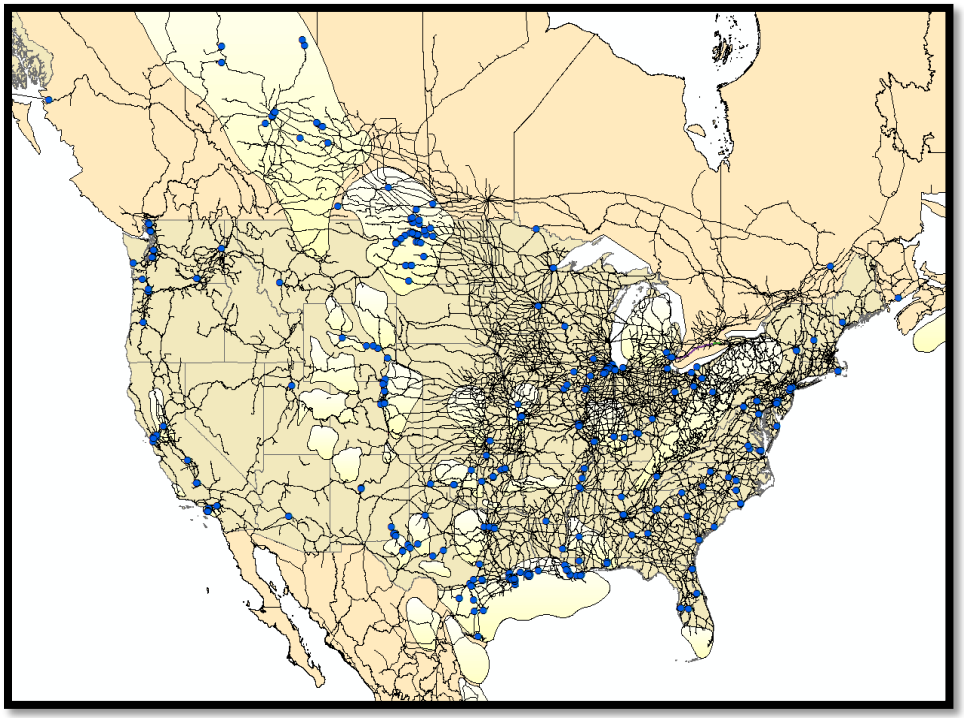
- Global Partners and Buckeye in Albany hub
- Global had received permits to double facility in 2012

- In January 2014 Gov Cuomo signed order for top bottom safety review of crude by rail and water and writes letter to Obama



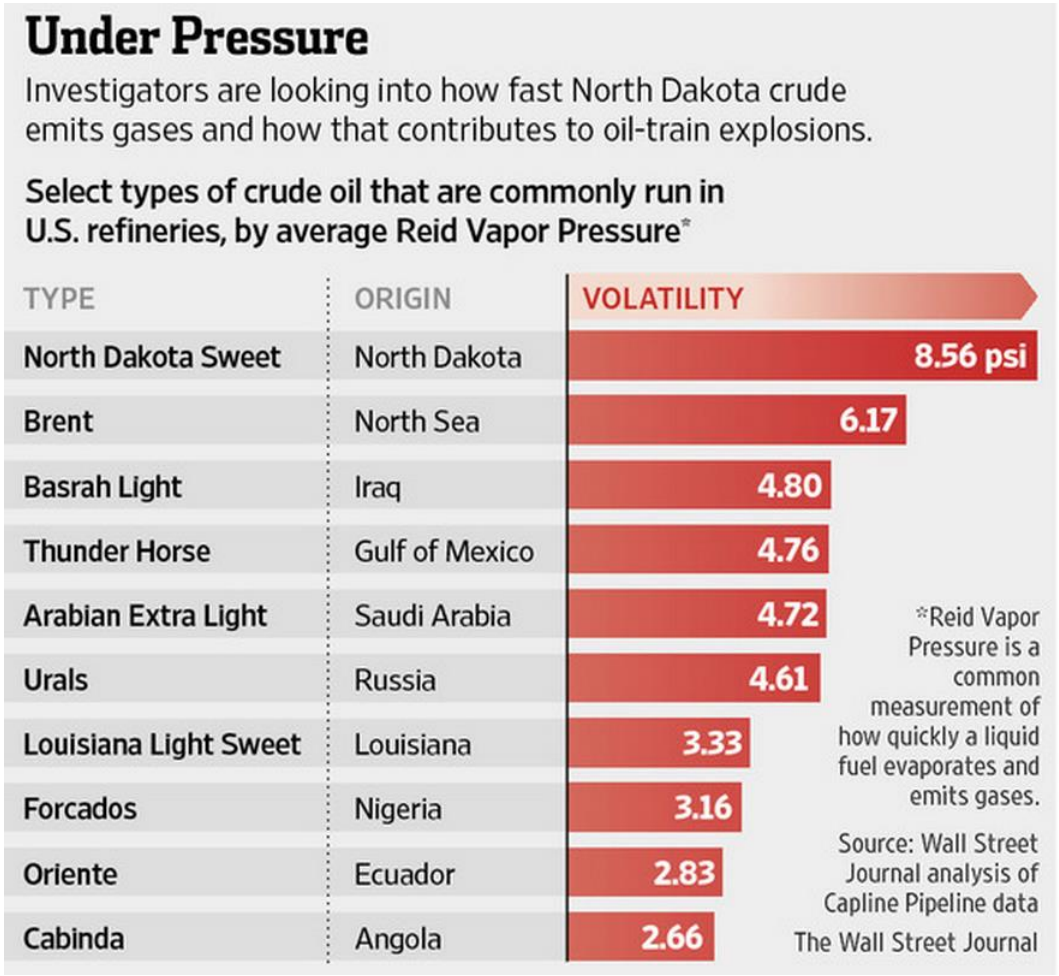
Source: New York Times, Jad Mouawad, "Bakken Crude, Rolling Through Albany," Feb 27, 2014

Class 1 vs. Shortline Railroads



Source: Wikipedia; EPRINC Maps using Hart Energy data and ArcGIS Mapping software

Bakken Crude Volatility

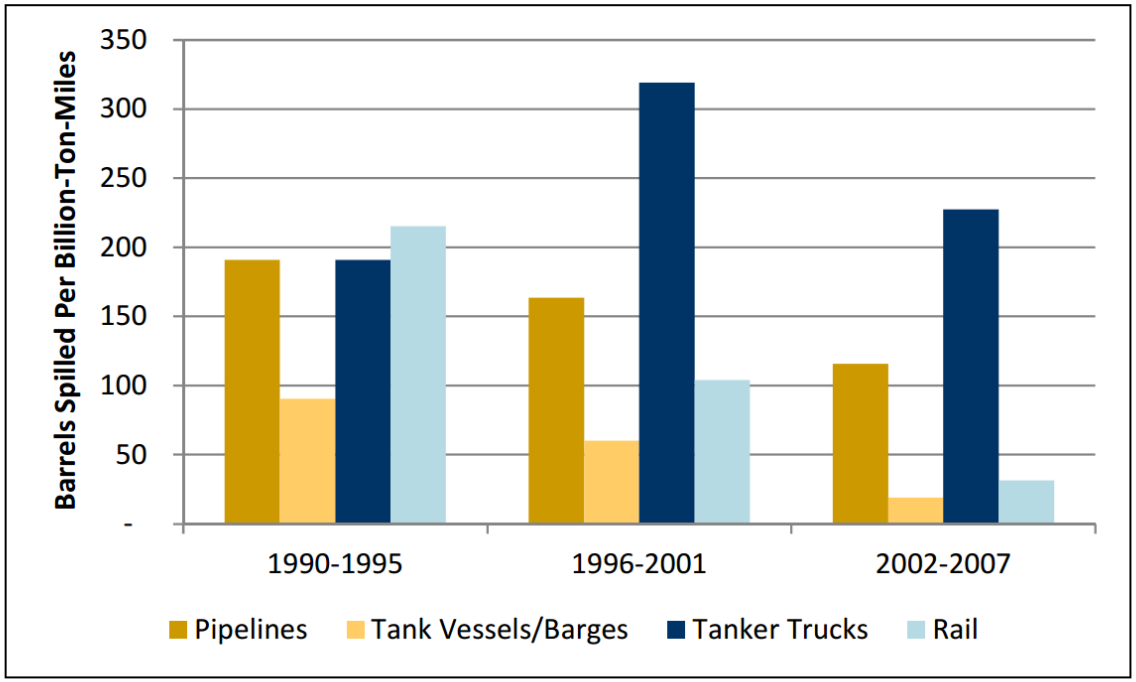


Source: WSJ, Russel Gold, "Bakken Shale Carries High Combustion Risk," Feb 23, 2014

Spill volume of rail through 2007

Figure 3. Oil Spill Volume per Billion-Ton-Miles

Crude Oil and Petroleum Products during Domestic Transportation



Sources: Prepared by CRS; oil spill volume data from Dagmar Etkin, *Analysis of U.S. Oil Spillage*, API Publication 356, August 2009; ton-mile data from Association of Oil Pipelines, *Report on Shifts in Petroleum Transportation: 1990-2009*, February 2012.

Notes: Pipelines include onshore and offshore pipelines. The time periods were chosen based on the available annual data for both spill volume and ton-miles. The values for each time period are averages of annual data for each six-year period.

Source: CRS Rail Transportation of Crude Oil, May 2014