ENBRIDGE LINE 3

REPLACEMENT PROJECT

MARKET ANALYSIS

October 2014

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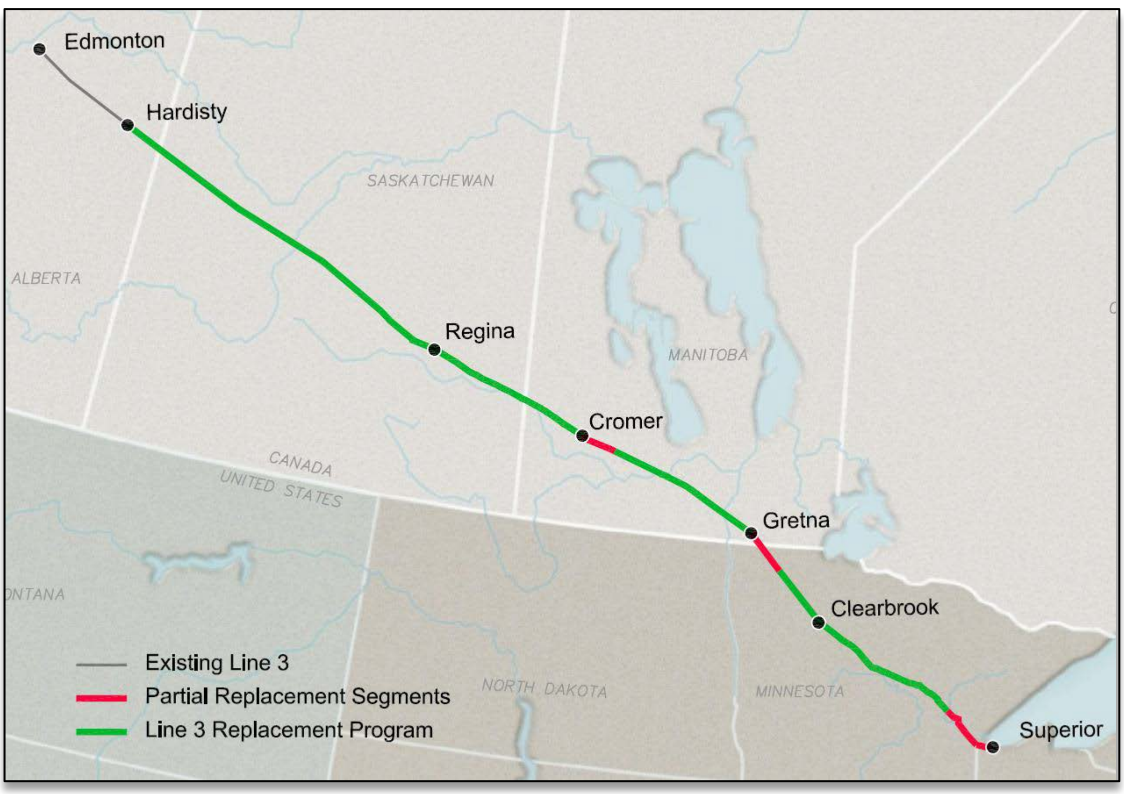
INTRODUCTION

Line 3, built in 1968 as part of the Enbridge's Lakehead System, is an 864 millimeter (34-inch) diameter, 1,659-kilometer pipeline from Edmonton, Alberta, to Superior, Wisconsin. The Line 3 Replacement Program ("L3RP", or the "Project") will replace the existing pipeline with a 36-inch diameter pipeline between Hardisty, Alberta, and Gretna, Manitoba, as well as between Neche, North Dakota, and Superior, Wisconsin. The approximate pipeline routing is shown in Figure 1. The estimated in-service date is the end of 2017. Muse has been advised by Enbridge that Line 3 annualized average daily capacity will be 760 thousand barrels per day (kb/d) once the Project is completed.

Figure 1



Appendix 1 provides an overview of the Enbridge Mainline pipeline system, of which Line 3 is a component. As noted in Appendix 1, the individual pipelines within the Enbridge Mainline system transport a variety of crude oil grades, and individual pipelines tend to be dedicated to specific crude oil grades to maximize operational efficiency. The capacity of the individual pipelines within the Enbridge Mainline system, including Line 3, is influenced by the physical characteristics (density, viscosity, etc.) of the fluids being transported.

The key conclusions of this report are:

- There is a demonstrable market need for the Project.

- There is sufficient demand for Western Canadian crude oil in the markets served such that the Enbridge Mainline generally will be operating at or close to capacity throughout the forecast period ending in 2030.

The basis for those conclusions is set forth in the body of this report.

This report was written by Neil K. Earnest, President of Muse, Stancil & Co. (Muse). Other employees of Muse also assisted with the preparation of this report. It is Muse's professional judgment that the key assumptions used to develop the conclusions and opinions presented in this report are reasonable and well founded.

EXECUTIVE SUMMARY AND CONCLUSIONS

The Project will enhance the Enbridge Mainline's existing ability to transport crude oil from Western Canada to the crude oil markets in Ontario, Quebec, and the Midwest. Other downstream pipelines provide connectivity from the Mainline to important crude oil markets in the Midcontinent and lower Midwest regions, plus the Gulf Coast.

This purpose of this report is:

- Estimate the utilization of the Enbridge Mainline to the border; and
- Provide a comparison of Western Canadian crude oil supply forecast data between the publicly available independent sources.

The 2014 Canadian Association of Petroleum Producers (CAPP) Western Canadian crude oil supply forecast has been used for this analysis. The CAPP supply forecast extends to 2030. Therefore, the period considered by this report is 2018 to 2030.

The Cromer-to-Clearbrook segment of the Enbridge Mainline is used for capacity utilization analysis because it is downstream of all of the Canadian crude oil delivery points, and it is the last station on the Enbridge Mainline at which crude oil is received.[1] Throughout the forecast period, the total effective Enbridge Mainline capacity at Cromer is 2,891 kb/d. This value represents 95 percent of the summed capacity of the individual Enbridge Mainline pipelines.[2] The summed capacities are adjusted with an effective utilization factor of 95 percent. This percentage is based on Enbridge's historical, and projected, experience with managing such issues as late receipts,

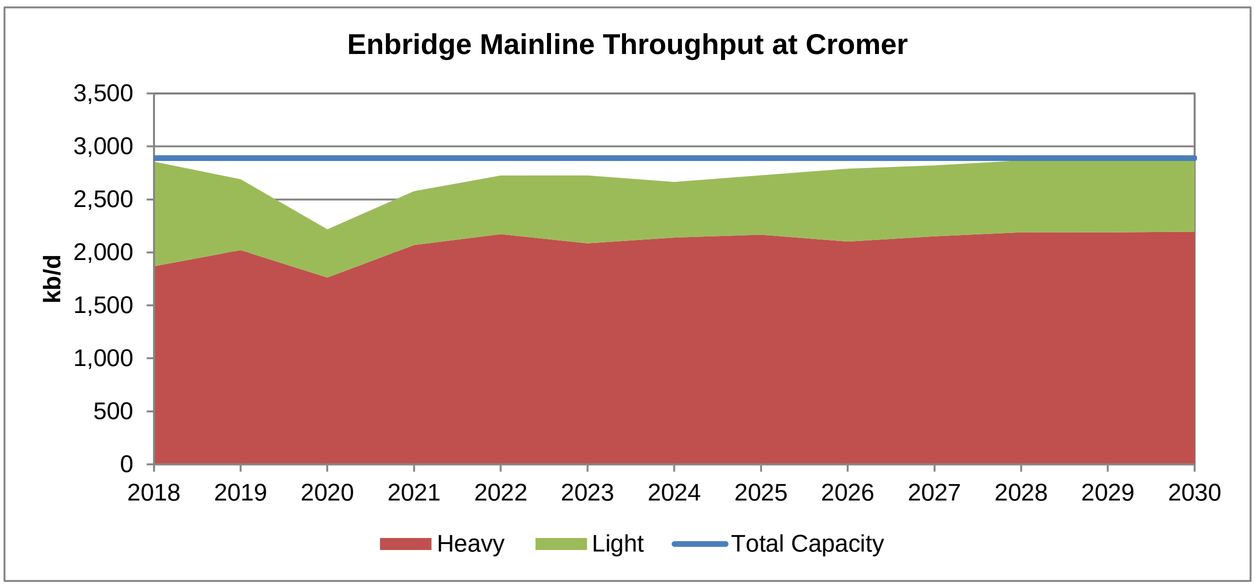
[1] Refined product deliveries are made downstream of Cromer at Gretna, but this does not change the pipeline capacity available for crude oil transportation. In addition to Canadian receipts, Cromer also receives U.S. crude oil via the Enbridge North Dakota system.

[2] Net of the capacity consumed by refined product and natural gas liquids shipments.

refiners unable to accept deliveries because of operational problems, and terminal tankage constraints. The 95 percent effective utilization factor was provided by Enbridge.

Figure 2 provides the projected throughput at Cromer of the Enbridge Mainline with the L3RP in service. In the initial year of operation, the Enbridge Mainline is forecast to operate essentially at full capacity. Mainline utilization drops in 2019 because of the start-up of the Northern Gateway pipeline. To assess the impact of the start-up of a second large export pipeline, it also has been assumed that the Energy East pipeline is commissioned in 2020.[3] Consequently, the Enbridge Mainline utilization drops again in 2020 due to the start-up of Energy East, followed by a steady increase in utilization as Western Canadian crude oil supply continues to grow.

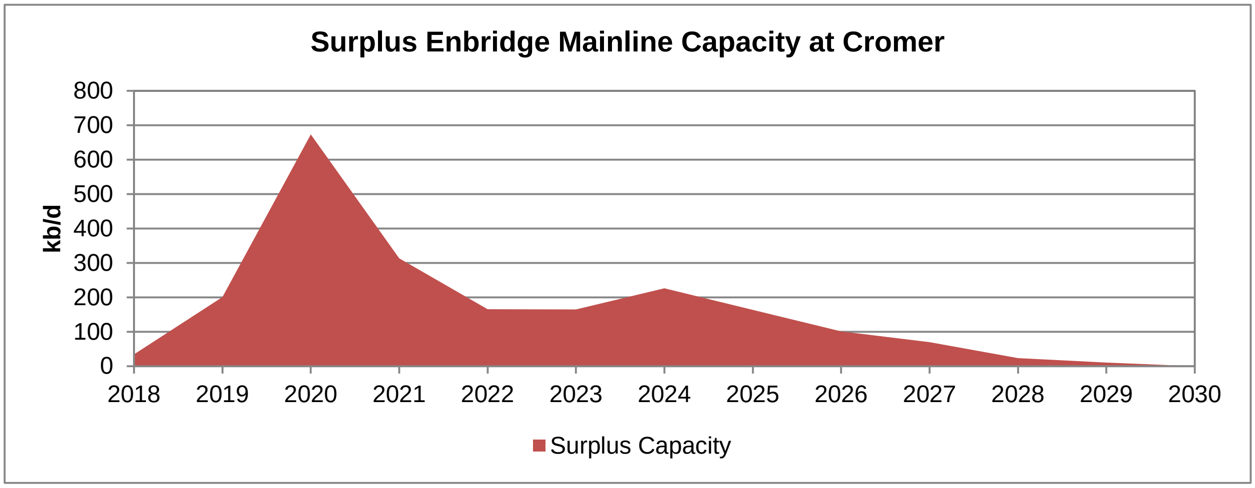
Figure 2



[3] To perform the analysis, assumptions had to be made about various potential new export pipelines. These assumptions are intended to represent only a reasonable future scenario. They should not be taken to be reflective of Muse's professional opinion regarding the merits of the various pipeline projects or the most likely pipeline commissioning dates.

Figure 3 shows the difference between the projected Enbridge Mainline throughput at Cromer and the effective capacity of the Enbridge Mainline. The analysis indicates that Line 3 will be utilized over the entire forecast period.

Figure 3

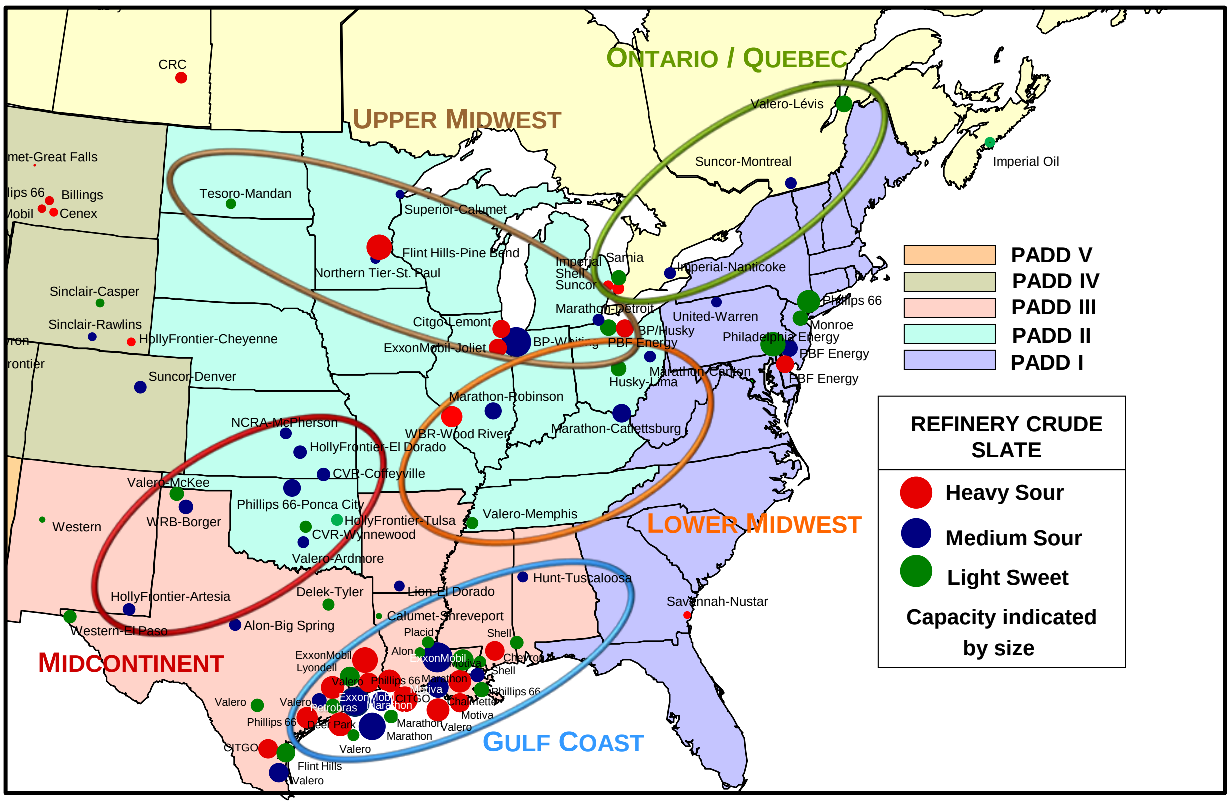


Comparison of Independent Canadian Crude Oil Supply Forecasts – Forecasts of Western Canadian crude oil production generated by independent sources differ in the details, but communicate the same message — the forward outlook for Western Canada is one of large increases in crude oil supply. As a practical matter, the increases must be transported to the market by some combination of pipeline and rail. The Project represents a small portion of the transportation capacity that will have to be utilized over the next decade.

CRUDE OIL MARKET OVERVIEW

To analyze the North American crude oil markets, Muse generally aggregates the 150+ individual North American refineries into regional submarkets that share similar crude oil transportation options.[4] Five submarkets are accessible to Canadian crude oil transported via the Mainline: Upper Midwest; Lower Midwest; Ontario/Quebec; Midcontinent; and the Gulf Coast.[5] Figure 4 provides the geographical definition of the five refinery submarkets accessible, directly or indirectly, via the Enbridge Mainline, and Appendix 2 shows the major crude oil pipelines throughout the U.S.

Figure 4



[4] For purposes of this report, North America consists of Canada and the United States.
[5] In addition to these markets, crude oil can also be delivered to Montreal and then potentially transported via small tankers to the global crude oil market. In the context of the total North American crude oil supply and demand balance, these potential shipments are immaterial.

The Upper Midwest and Ontario/Quebec submarkets are primarily accessible from Western Canada via the Enbridge Mainline. The rest of the submarkets can be accessed via both the Enbridge Mainline and the Keystone pipeline. This latter pipeline originates at Hardisty, Alberta. The Midcontinent and Gulf Coast can be accessed from the Enbridge Mainline via the Flanagan South and Spearhead pipelines.

UPPER MIDWEST

The Upper Midwest is a major demand center for Canadian light and heavy crude oil today, and will remain so for the foreseeable future. Table 1 provides the capacities of the refineries located in the Upper Midwest.[6]

Table 1

UPPER MIDWEST

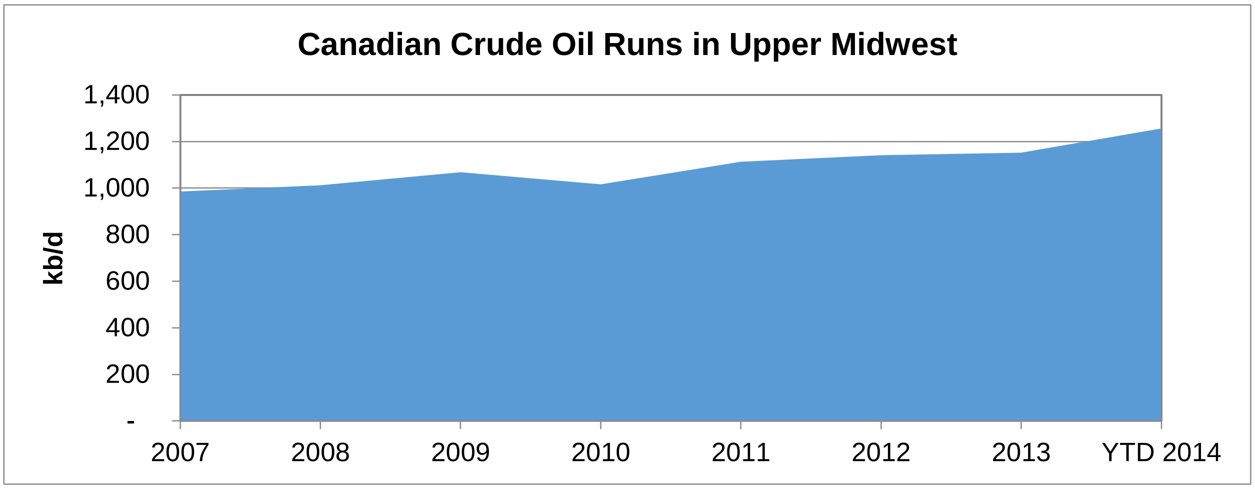
Refinery	***State***	***kb/d***
BP Whiting	Indiana	413.5
BP-Husky Toledo	Ohio	135.0
Calumet Superior	Wisconsin	38.0
CITGO Lemont	Illinois	172.0
ExxonMobil Joliet	Illinois	238.6
Flint Hills Pine Bend	Saint Paul	270.0
Marathon Detroit	Michigan	123.0
Northern Tier Energy St. Paul	Minnesota	89.5
PBF Toledo	Ohio	160.0
Tesoro Mandan	North Dakota	70.0
Total		**1,709.6**

Figure 5 provides the volume of Western Canadian crude oil delivered to this submarket over the last 7 years, including the year-to-date data for 2014. Canadian crude oil

[6] The U.S. refinery capacities in this report section are obtained from the EIA *Refinery Capacity Report,* June 25, 2014, available at http://www.eia.gov/petroleum/refinerycapacity/. Two small North Dakota refineries that are in the planning or construction phase are not shown.

supply has been growing steadily, and now the volume of Canadian crude oil supply exceeds that supplied from U.S. sources.

Figure 5



LOWER MIDWEST

Total refinery capacity for this region is almost 1,300 kb/d, as shown in Table 2. Marathon is currently engaged in constructing two condensate splitters at its Canton and Catlettsburg refineries with a capacity of 25 and 35 kb/d, respectively. The incremental capacity of the splitters is included in the refinery capacities shown in Table 2. In addition, Marathon is expanding its light crude oil capacity by 30 kb/d at its Robinson refinery.[7]

[7] Marathon Petroleum Company Investor Presentation, May 2014, slide 26.

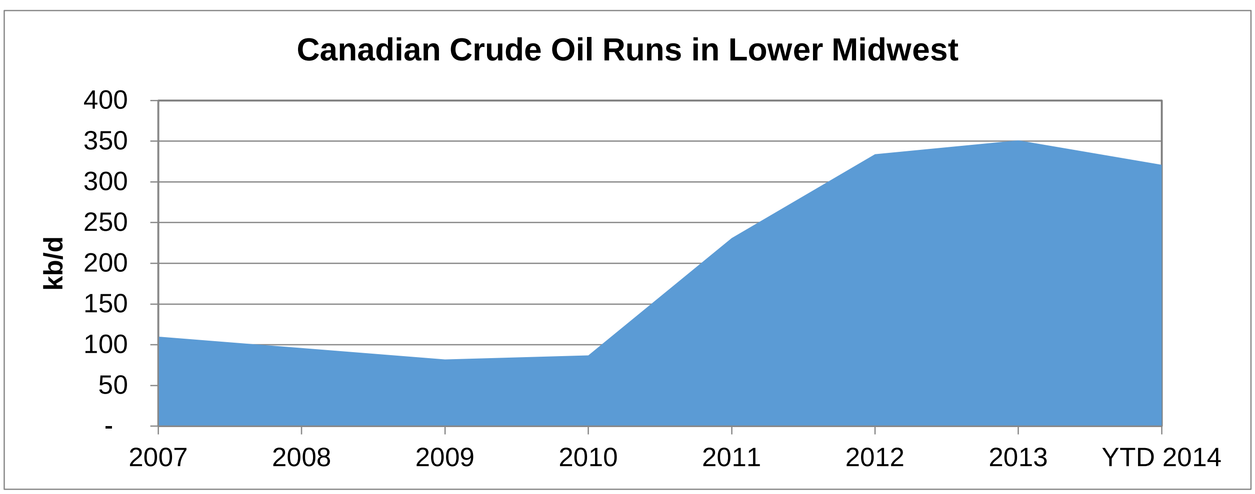
Table 2

LOWER MIDWEST

Refinery	***State***	***kb/d***
CountryMark Mt. Vernon	Indiana	27.1
Husky Lima	Ohio	155.0
Marathon Canton	Ohio	105.0
Marathon Catlettsburg	Kentucky	277.0
Marathon Robinson	Illinois	212.0
Valero Memphis	Tennessee	180.0
WRB Wood River	Illinois	314.0
Total		**1,270.1**

Western Canadian crude oil runs in this submarket are provided in Figure 6. The relatively recent increase in Canadian crude oil runs is attributable to the start-up in the summer of 2010 of the Keystone pipeline to this region. The Keystone pipeline delivers Canadian crude oil to the large WRB Wood River refinery and the Patoka, Illinois, pipeline hub. This latter location is connected to a number of refineries in the Lower Midwest.

Figure 6



ONTARIO/QUEBEC

Table 3 provides the current capacity of the refineries located in the Ontario/Quebec submarket.[8] The United Warren refinery, located in western Pennsylvania, is also included in this submarket because it receives its crude oil supplies via Ontario on the Enbridge Mainline, and has substantially the same crude oil transportation economics as the Ontario refineries.

Table 3

ONTARIO/QUEBEC

Refinery	*State/Province*	*kb/d*
Nova Corunna	Ontario	80.0
Imperial Nanticoke	Ontario	113.5
Imperial Sarnia	Ontario	119.0
Shell Sarnia	Ontario	71.0
Suncor Sarnia	Ontario	85.0
Suncor Montreal	Quebec	137.0
Valero Levis	Quebec	235.0
United Warren	Pennsylvania	65.0
Total		**905.5**

[8] The Canadian refinery capacities are obtained from the *Oil & Gas Journal*, *2014 Worldwide Refining Survey*, December 2, 2013.

MIDCONTINENT

Table 4 provides the refinery capacities in the Midcontinent submarket. Muse's definition of the Midcontinent submarket includes the Valero McKee and the WRB Borger refineries in the Texas Panhandle, as well as the HollyFrontier Artesia refinery in southeastern New Mexico. These three refineries can receive crude oil via the Cushing pipeline hub.

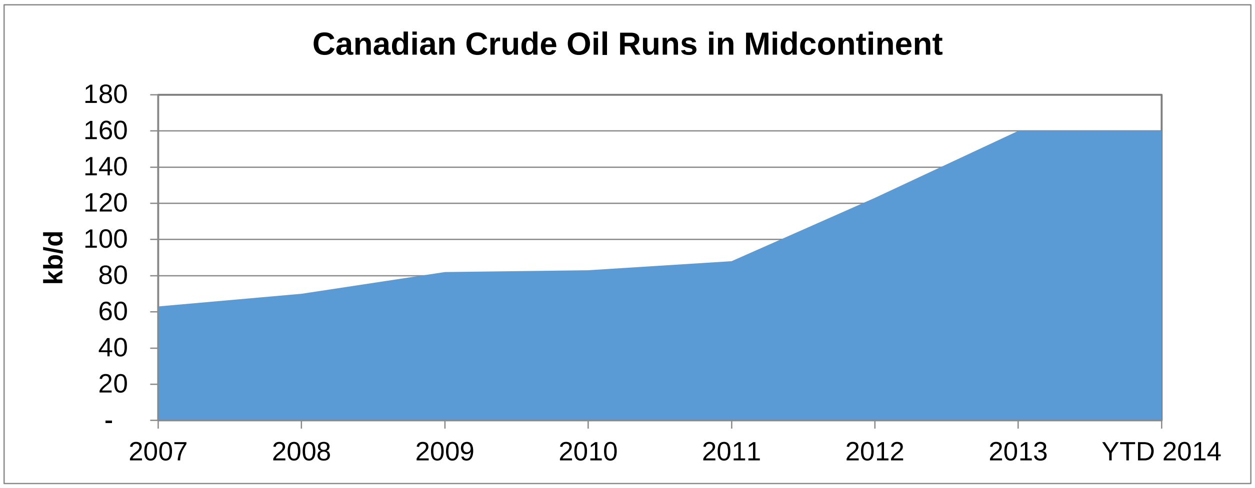
Table 4

MID-CONTINENT

Refinery	***State***	***kb/d***
CVR Energy Coffeyville	Kansas	115.0
CVR Energy Wynnewood	Oklahoma	70.0
HollyFrontier El Dorado	Kansas	138.0
HollyFrontier Artesia	New Mexico	105.0
Holly Frontier Tulsa	Oklahoma	155.3
NCRA McPerson	Kansas	86.0
Phillips 66 Ponca City	Oklahoma	200.0
Valero Ardmore	Oklahoma	86.0
Valero McKee	Texas	156.0
WRB Borger	Texas	146.0
Total		**1,257.3**

Figure 7 shows the Canadian crude oil runs at the Midcontinent refineries. Runs have approximately doubled in the last few years, reflecting the start-up of the Keystone pipeline to Cushing, Oklahoma, in early 2011.

Figure 7



GULF COAST

Total Gulf Coast refining capacity is approximately 8,000 kb/d, and is the largest concentration of refining capacity in the world. The Gulf Coast is further subdivided into the Corpus Christi, Houston, Beaumont/Port Arthur/Lake Charles, and Louisiana/Mississippi submarkets, reflecting the somewhat different logistical costs and constraints associated with reaching these areas from Western Canada.

Historically, the Canadian crude oil runs on the Gulf Coast have not been appreciable relative to the amount of refining capacity on the Gulf Coast. Figure 8 provides the historical volumes.[9] Table 5 details the crude oil distillation capacity of the individual Gulf Coast refineries.

[9] It is possible that some of the Canadian crude oil supply to the Gulf Coast originated from the fields offshore Atlantic Canada, rather than Western Canada. The EIA also reports some relatively small deliveries of Canadian crude oil to various terminals on the Gulf Coast, but not the refinery that ultimately processed the barrels.

Figure 8

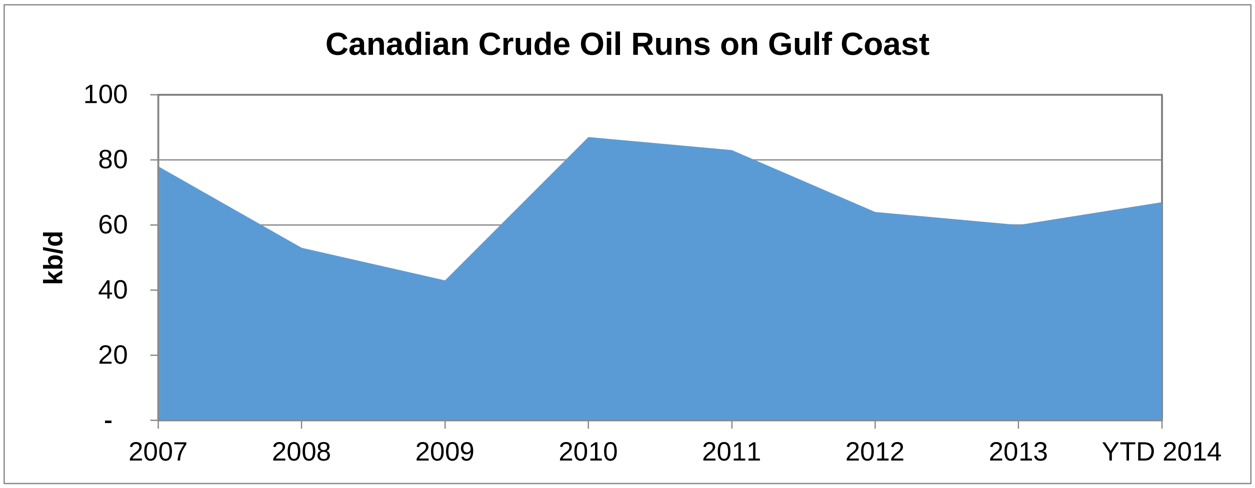

Canadian Crude Oil Runs on Gulf Coast
kb/d
100
80
60
40
20
-
2007
2008
2009
2010
2011
2012
2013
YTD 2014

Table 5

GULF COAST

Refinery	***State***	***kb/d***
Corpus Christi		
CITCO Corpus Christi	Texas	163.0
Flint Hills Corpus Christi	Texas	293.0
Valero Corpus Christi	Texas	200.0
Valero Three Rivers	Texas	93.0
Subtotal		**749.0**
Houston		
ExxonMobil Baytown	Texas	560.5
LyondellBasell Houston	Texas	263.8
Marathon Galveston Bay	Texas	451.0
Marathon Texas City	Texas	84.0
Pasadena Refining Pasadena	Texas	100.0
Phillips 66 Sweeny	Texas	247.0
Deer Park Refining Deer Park	Texas	327.0
Valero Houston	Texas	88.0
Valero Texas City	Texas	225.0
Subtotal		**2,346.3**
Beaumont/Port Arthur/Lake Charles		
CITGO Lake Charles	Louisiana	427.8
ExxonMobil Beaumont	Texas	334.6
Motiva Port Arthur	Texas	600.3
Phillips 66 Westlake	Louisiana	239.4
Total Port Arthur	Texas	225.5
Valero Port Arthur	Texas	330.0
Subtotal		**2,157.6**
Louisiana/Mississippi/Alabama		
Alon Krotz Springs	Louisiana	80.0
Chalmette Refining	Louisiana	192.5
Chevron Pascagoula	Mississippi	330.0
ExxonMobil Baton Rouge	Louisiana	502.5
Hunt Tuscaloosa	Alabama	36.0
Marathon Garyville	Louisiana	522.0
Motiva Convent	Louisiana	235.0
Motiva Norco	Louisiana	238.0
Phillips 66 Alliance	Louisiana	247.0
Placid Port Allen	Louisiana	59.0
Shell Saraland	Alabama	80.0
Valero Mereaux	Louisiana	125.0
Valero Norco	Louisiana	205.0
Subtotal		**2,852.0**
Grand Total		**8,104.9**

DESCRIPTION OF ANALYTICAL METHODOLOGY

The Muse Crude Oil Market Optimization Model has been used to quantify the expected throughput on Enbridge Mainline, using a reasonable scenario of Canadian crude oil supply and of export pipeline developments. The following discussion describes the methodology and assumptions used in this report.

The Crude Oil Market Optimization Model is a mathmatical representation of the North American crude oil distribution system, including rail and water transportation modes, that predicts the flow of crude oil to various markets and the crude oil prices that result from such flows. Optimization algorithms embedded in the model are used to generate the most efficient crude oil distribution pattern that acts to maximize the crude oil price received by the U.S. and Canadian crude oil producer. Consequently, it is well-suited for assessing the market implications of changes in the logistical infrastructure that enables Western Canadian crude oil to reach the market.

The model uses linear programming (LP) techniques to allocate all North American crude oil production among Canadian, U.S., Northeast Asian, European, and Indian refineries, within the confines of existing and expected pipeline, rail, barge, and refinery capacity constraints. The model is seeking to maximize the North American crude oil netback price at the point of injection into the transportation system.[10] Said differently, the model is seeking to route all North American crude oil to the refineries that will pay the most for the crude oil, taking into consideration the transportation costs from the injection point to the refinery, while simultaneously having due regard for the finite capacities of the pipeline and rail routes (and the refineries themselves). In essence,

[10] The netback price is the price that a specific grade of crude oil is sold for at its market-clearing point, less the transportation cost between the injection point and the market-clearing point. The market-clearing point is also frequently referred to as the parity point. The parity point can, and does, differ between crude oil grades (heavy sour, light sweet, etc.).

the model attempts to mirror the crude oil distribution pattern that would arise from an efficiently operating crude marketplace. The model is not seeking to maximize or minimize the throughput of the Enbridge Mainline or any other pipeline.

The inputs to the model include:

1. The supply of Western Canadian and U.S. crude oil (by major production area), by individual crude oil grade (heavy sour, light sweet, etc.);

2. The capacity of each pipeline, rail, and barge route (by segment, where necessary);

3. Where applicable, pipeline volume commitments;

4. The pipeline tolls/rates and other transportation costs (e.g., tanker, barge, and rail costs);

5. The crude oil capacity of each refinery as well as refinery-specific constraints; and

6. The refining value of the crude oil grades at each refinery, expressed as a function of crude oil throughput.

Once the variables are input into the model, LP techniques are used to maximize the desired outcome, which in this case is the aggregate crude oil netback, while simultaneously satisfying all of the constraints imposed upon the solution.

MODEL INPUT: CRUDE OIL SUPPLY

The June 2014 CAPP forecast is the basis for the Western Canadian crude oil supply projection.[11] For U.S. crude oil production, Muse used a modified version of the latest

[11] CAPP, *Crude Oil Forecast, Markets & Transportation*, June 2014.

Energy Information Administration (EIA) *Annual Energy Outlook* supply forecast. Muse adjusts some of the tight oil supply volumes in the EIA supply forecast.

MODEL INPUT: CRUDE OIL TRANSPORTATION INFRASTRUCTURE

The North American crude oil pipeline network modeled is that which exists today plus all significant pipeline projects in development that are reasonably expected, by Muse, to proceed to completion.[12] Major Enbridge expansion projects, both in Canada and the U.S., are also included in the Crude Oil Market Optimization Model. Details regarding the pipeline assumptions follow:

- **Keystone XL.** An origination capacity at Hardisty of 700 kb/d is used for the Keystone XL pipeline with an in-service date of January 1, 2017. A total volume commitment of 910 kb/d is used for the Keystone system (XL plus Legacy Keystone). The volume commitment acts to limit the total crude oil volume that can be transported at the committed tolls on the Keystone system. Destination-specific volume commitments are not imposed, and the committed barrels can be routed to Wood River, Patoka, Cushing, Beaumont-Port Arthur, and Houston, subject to the capacity of the individual pipeline segments of the Keystone system. The volume commitments are assumed to expire in 20 years. Muse has further assumed that the Bakken Marketlink and Cushing Marketlink components of the Keystone XL project also proceed. For the Bakken and Cushing Marketlink projects Muse has used volume commitments of 65 kb/d and 75 kb/d, respectively.

- **Enbridge Flanagan South.** The Enbridge Flanagan South pipeline project is commissioned in 2014 with a capacity of 585 kb/d with a sizable volume commitment. The Flanagan South pipeline will originate in the

[12] California and offshore Gulf of Mexico crude oil pipelines are not included in the model, as they have little influence on the distribution of crude oil elsewhere in North America.

Chicago area and terminate at the U.S. Gulf Coast. The segment of the Flanagan South pipeline between Cushing and the Gulf Coast will be leased from Seaway pipeline (see below).

- **Seaway System.** Muse has assumed that the existing Seaway pipeline will be twinned by 2015 to provide a total southbound crude oil capacity between Cushing and Houston, Texas, of 850 kb/d, with a 600 kb/d extension from Houston to the Beaumont/Port Arthur, Texas area. (As noted, a portion of the capacity of the twinned Seaway system will be leased to Flanagan South.) There are volume commitments for both Seaway and Flanagan South associated with the twinned Seaway system.[13]

- **Enbridge Mainline and Affiliated Pipelines.** The Enbridge Mainline is a multi-line system which transports both light and heavy crude oils. The modeling approach for the Enbridge Mainline permits light crude oil to be transported on the heavy crude oil pipelines, e.g., Line 67, but does not allow heavy crude oil to be shipped on the dedicated light crude oil pipelines, e.g., Lines 1 and 2. Accordingly, each Enbridge Mainline segment is modeled with a heavy crude oil and a total crude oil (light plus heavy) capacity constraint. In addition, as is the case today, no volume commitments have been assumed for the Enbridge Mainline. By 2018, the following Mainline segments will have (prior to the application of an effective utilization factor) capacity of:
    - **Cromer to Clearbrook** – Total crude oil capacity of 3,044 kb/d, heavy crude oil capacity of 2,356 kb/d;[14]

[13] The Flanagan South volume commitments, at their peak, will total 537 kb/d according to the Petition for Declaratory Order for that project filed in FERC Docket No. OR14-5-000. Seaway had volume commitments of 100,000 kb/d as of 2013; the ultimate level of Seaway volume commitments has not been publicly disclosed.
[14] The Enbridge Mainline upstream of Cromer is not included in the Crude Market Optimization Model.

- **Clearbrook to Superior** – Total crude oil capacity of 3,233 kb/d; heavy crude oil capacity of 2,356 kb/d. The total crude oil capacity includes that contributed by the Sandpiper pipeline segment between Clearbrook and Superior;
- **Superior to Chicago** – Total capacity of 984 kb/d in mixed service;
- **Superior to Flanagan** – Total capacity of 1,200 kb/d in mixed service;
- **Superior to Sarnia (Line 5)** – Total capacity of 505 kb/d in dedicated light service;[15]
- **Chicago to Stockbridge (Line 6B)** – Total capacity of 570 kb/d in mixed service;
- **Sarnia to Westover and Montreal (Line 9)** – Total capacity of 300 kb/d, with heavy crude oil capacity of 50 kb/d; and
- **Southern Access Extension** – Total capacity of 300 kb/d in mixed service.

• **Northern Gateway Project.** Muse has assumed that the Northern Gateway project proceeds as of 2019 with a capacity of 525 kb/d with a volume commitment of 500 kb/d.

• **Enbridge North Dakota System.** The following capacities have been used for the Enbridge North Dakota system:
  - To Clearbrook – 435 kb/d; and
  - To Cromer – 145 kb/d.

• **Trans Mountain.** Total capacity is 300 kb/d, less an estimated 45 kb/d of refined product shipments. The Westridge dock capacity is 79 kb/d.

[15] In 2018, Line 5 capacity is reduced by approximately 36 kb/d to account for shipments of natural gas liquids (NGLs) in the pipeline. NGL shipments are assumed to decrease by about 2 percent per year, and the Line 5 capacity available for crude shipments increases commensurately.

- **TransCanada Energy East.** Muse has assumed that the Energy East project will proceed in 2020 with an origination capacity of 1,080 kb/d, with delivery destinations at Montreal, Levis (both in Quebec), and St. John, New Brunswick. At St. John, a marine loading facility capable of loading very large crude carriers (VLCCs) has been modeled. Volume commitments totaling 900 kb/d have been assumed.

- **Rockies.** Total crude oil export pipeline capacity from Canada to the Rockies (PADD IV) is estimated to be 514 kb/d throughout the forecast period. The Crude Market Optimization Model does not individually model the various export pipelines that connect Alberta with the Rockies. The outbound (from the Rockies) capacities of the Platte and White Cliffs pipelines are estimated to be 145 kb/d and 150 kb/d, respectively, as of 2016. The Butte/Belle Fourche pipeline system is expanded to 316 kb/d.

- **Other U.S. Pipeline Projects.** Muse has made the following assumptions regarding other U.S. pipeline projects. All of these projects are either in service or an advanced commercial development phase and, in the opinion of Muse, are likely to proceed.
  - The Magellan Longhorn pipeline is in crude oil service between West Texas and the Houston area at a total capacity of 225 kb/d with volume commitments.
  - The Magellan BridgeTex pipeline is in service at a capacity of 300 kb/d with volume commitments.
  - The Sunoco West Texas Expansion, Permian Express, and Amdel pipelines have a total capacity of 260 kb/d.
  - The Plains Cactus project is in service with a capacity of 250 kb/d.
  - The Shell Ho-Ho pipeline is reversed to transport crude oil from the Houston area to Louisiana with an origination capacity at Houston of 300 kb/d and 375 kb/d at Beaumont.

- **Rail and Barge.** Barges are currently being used to transport Western Canadian crude down the Mississippi River, and rail has emerged as a credible transportation mode for large volumes of crude oil. For example, by the end of 2013, an estimated 865 kb/d of rail loading capacity will be in place in the Williston Basin, mostly in North Dakota.[16] Assumptions regarding barge and rail transport follow:
  - Barge capacity is assumed to be 110 kb/d in 2018. The barge route is via the Mississippi River from the Wood River area to Louisiana.
  - Total rail capacity for Western Canadian crude oil to the British Columbia ports, for further transportation by tanker to the Pacific markets, is assumed to be 75 kb/d in 2018, and grows to 525 kb/d by 2030. In practice, the volume of crude oil that can be transported by rail to British Columbia ports is likely to be more limited by constraints at the ports themselves rather than railroad capacity. The tanker cost from Kitimat, B.C., to the various Pacific markets is used.
  - Total rail capacity for Bakken and Western Canadian crude oil to the Gulf Coast is assumed to be 385 kb/d in 2018. Slightly different rail costs are used for the Houston, Beaumont/Port Arthur, and Louisiana markets.
  - Total rail capacity for Bakken and Western Canadian crude oil to the Washington state refineries is assumed to be 205 kb/d in 2018, and grows to 240 kb/d by 2030.
  - Total effective rail capacity for Bakken crude oil to all destinations is assumed to be 825 kb/d in 2018.

Pipeline tolls and rates are obtained from the National Energy Board (NEB), Federal Energy Regulatory Commission (FERC), and state tariff filings. For the Enbridge

[16] IEA, *2013 Medium-Term Market Report*, Table 6.

Mainline system that extends from Alberta to the Midwest and Ontario, the model uses the tariff rates as detailed in the Competitive Toll Settlement entered into by Enbridge before the NEB in Canada, adjusted using information from Enbridge regarding the toll impact of pipeline projects (including the L3RP) that are not yet in service. The barge and rail costs are largely based on Muse's industry experience and research. The Crude Oil Market Optimization Model uses constant real (versus nominal) crude oil prices and pipeline rates in 2014 dollars.

Consistent with our practice in other studies, all volume commitments are modeled as shipments that can take place at discounted tolls, rather than as minimum throughput obligations. This more closely mimics actual market behavior, in that it recognizes that committed shippers incur low incremental cash costs to ship, but are not obligated to physically ship the barrels if they choose to pay the deficiency instead.

MODEL INPUT: REFINERY CAPACITY

Within the Crude Oil Market Optimization Model, most refineries located in Canada, the Puget Sound area, the Midwest, the Mid-Continent, and the U.S. East Coast are individually represented. Most refineries located in Northern China, Southern China, Japan, Korea, Taiwan, Europe, India, U.S. Gulf Coast, the Rockies, and California are represented as a number of aggregates, rather than as individual refineries, mostly due to the large number of refineries in these areas. For U.S. refineries, crude capacities are obtained from the U.S. Energy Information Administration (EIA) *Refinery Capacity 2014 Report*, adjusted by Muse as appropriate to incorporate known capacity expansions.[17] Capacity information for other refineries is obtained from the *Oil & Gas Journal 2013 Worldwide Refining Survey*, frequently supplemented with information from company and other public sources.[18] Muse has applied utilization factors, which vary somewhat by region and refinery, to the indicated calendar day capacities within the Crude Oil Market Optimization Model.

[17] EIA, *Refinery Capacity 2014*, Table 3, "*Capacity of Operable Petroleum Refineries by State as of January 1, 2014.*"
[18] *Oil & Gas Journal,* December 2, 2013.

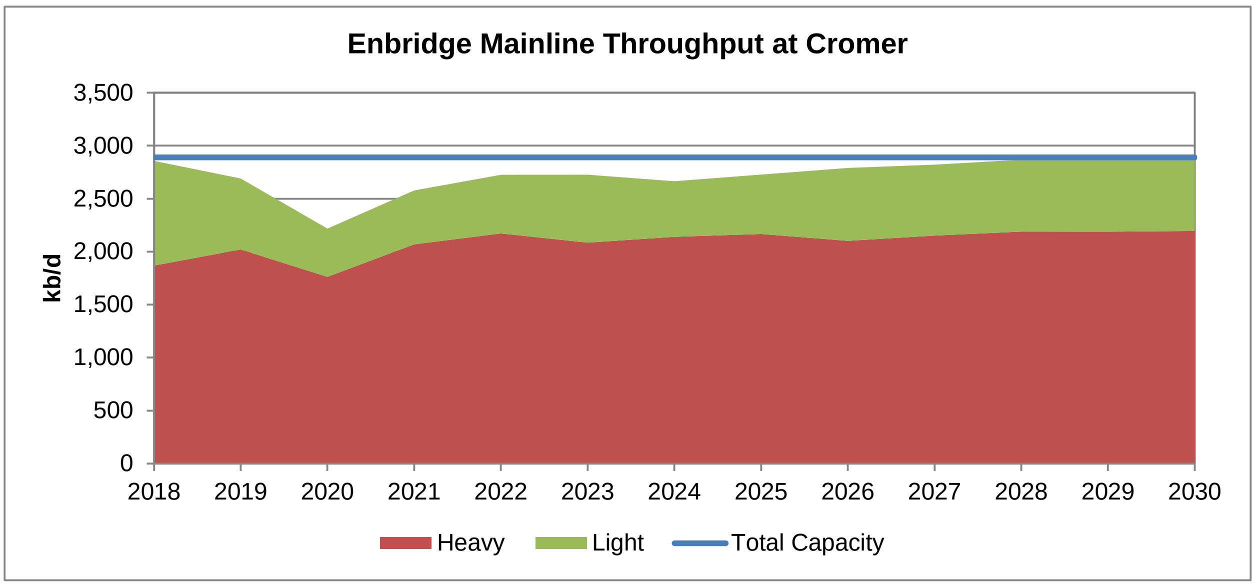
MODEL INPUT: CRUDE OIL REFINING VALUES

A key input variable to the Crude Oil Market Optimization Model is the value of various North American crude oils to the potential refinery customers, which Muse refers to as the crude oil refining value. The refining values are developed by Muse via the use of highly complex refinery LP models. Muse licenses the AspenTech PIMS® modeling system, which is the same system used by over half of the North America refiners to optimize their refinery operations. The refiner's optimization objectives include crude selection, determining process unit run rates, and selecting the mix of refined products to be produced. The PIMS® models used by Muse are substantially identical to those used by the refiners themselves.

ANALYTICAL CONCLUSIONS

Figure 9 provides the projected Enbridge Mainline throughput at Cromer of both light and heavy crude oil. Cromer is used for the analysis because it is downstream of all of the Canadian crude oil delivery points and it is the last station on the Enbridge Mainline at which crude oil is received, which includes any deliveries of U.S. Bakken crude oil via the Enbridge North Dakota pipeline. The refined product deliveries made downstream of Cromer at Gretna do not change the capacity of the Enbridge Mainline to transport crude oil, as there are no Canadian crude oil receipts at Gretna.

Figure 9



For the entire forecast period considered here, the total effective Enbridge Mainline capacity is 2,891 kb/d. This value represents 95 percent of the summed capacity of the individual Enbridge Mainline pipelines (less the capacity consumed by refined product shipments to Gretna and natural gas liquids to the Sarnia area). The 95 percent effective utilization factor is based upon Enbridge's historical experience with the effect of operational issues such as late crude oil receipts, refineries unable to accept deliveries because of their own operational problems, and various crude oil terminal constraints. The 95 percent effective utilization factor was provided by Enbridge.

Table 6 provides estimated Enbridge Mainline crude oil throughput by crude oil type, the total effective capacity, and the resultant amount of surplus capacity. The peak year of capacity surplus is 2020, which is the year that it has been assumed that the 1,080 kb/d Energy East pipeline would be commissioned. In this year, the capacity surplus is somewhat less than the capacity of Line 3 (760 kb/d), which means that some portion of Line 3 is being utilized. In all other years of the forecast period, the capacity surplus is less than the incremental (370 kb/d) of capacity added as a result of the Project.

Table 6

Enbridge Mainline Capacity Utilization Analysis

(Thousands of Barrels per Day)

	2018	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*	*2029*	*2030*
Heavy Throughput	1,869.0	2,020.9	1,762.7	2,069.3	2,172.2	2,085.5	2,140.4	2,167.0	2,102.4	2,152.0	2,189.6	2,188.8	2,195.7
Light/Medium Throughput	987.9	669.7	455.2	508.6	553.6	641.0	524.6	560.7	687.8	669.6	678.3	692.0	695.7
Total Capacity	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3	2,891.3
Surplus Capacity	34.4	200.7	673.4	313.4	165.5	164.9	226.3	163.6	101.1	69.8	23.5	10.5	-

In summary, a reasonable scenario of potential future Canadian pipeline developments, combined with the latest CAPP crude oil supply outlook, demonstrates that the replaced Line 3 will be utilized throughout the forecast period. Moreover, except for a few years immediately following the startup of other large export pipelines, the incremental capacity provided by the Project will also be utilized.

CANADIAN SUPPLY FORECAST COMPARISON

There are two public forecasts of Western Canadian crude oil production. The NEB provides Canadian crude oil supply outlooks every other year. CAPP also releases forecasts annually, and the associated report contains a great deal of information regarding the basis for the Canadian crude oil supply outlook and of crude oil market developments. In Muse's experience, CAPP crude oil supply forecasts are commonly used for pipeline regulatory purposes in Canada and the U.S.

In Western Canada, the volume of individual grades (e.g., light, heavy) of crude oil production differs from the volume of individual crude oil grades supplied to the market. This is attributable to the following factors:

- The need to add diluent to the heavy crude oil grades to enable them to be transported by pipeline, as in their natural state they are too viscous to be economically transported via pipeline.[19]

- The considerable volume of heavy crude oil that is upgraded to a lighter, more valuable crude oil at a number of facilities in Western Canada. The upgrading of heavy crude oil to lighter crude oils in the Canadian upgraders changes the respective volume of light and heavy crude oil supplied to the market.

- The volumetric loss that typically occurs when a heavy crude oil is upgraded to a lighter crude oil. The magnitude of the volumetric loss depends upon the specific processing technology used in the upgrader.

[19] The need to use diluents to transport heavy crude oils by pipeline is not a uniquely Canadian issue. Heavy crude oils produced in Venezuela, Colombia, and central California all require the use of diluents to enable pipeline transport.

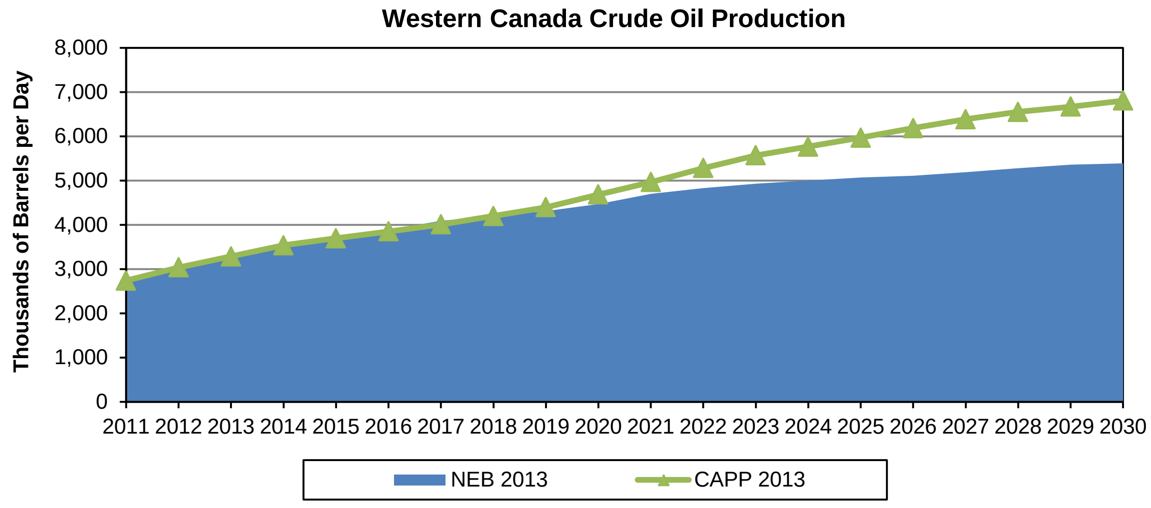
- Finally, some light crude oil is used as a diluent to enable heavy crude oil to be transported by pipeline, which also influences the ultimate volume of light versus heavy crude oil supplied to the market.

Consequently, the assumptions used by individual forecasters regarding the amount of upgrader capacity added over time, the type of upgrading capacity, and the amount of light crude oil used as diluent will result in somewhat different forecasts of the volume of crude oil supplied to the market, even if the underlying crude oil production forecast is identical. For purposes of assessing the need for additional pipeline capacity, the crude oil supply forecast is key, as this is the volume that must be actually transported to a market.

Figure 10 below provides a comparison of the NEB 2013 Reference Case production forecast to the CAPP production forecast of the same year.[20] Until about 2020, the production forecasts are very close. Post-2020, the NEB growth rate of crude oil production is less than that of CAPP, and by the end of the forecast period the NEB crude oil production volume is about 20 percent less than the CAPP production volume. Nonetheless, the most recent NEB forecast is projecting that between 2013 and 2030 the increase in crude oil production will be 2,100 kb/d.

[20] The NEB report is: *Canada's Energy Future 2013: Energy Supply and Demand Projections to 2035*, November 2013. The data for the NEB crude oil production outlook were obtained from Appendix Tables A3.3. The CAPP report is: *Crude Oil: Forecast, Markets & Transportation*, June 2013.

Figure 10

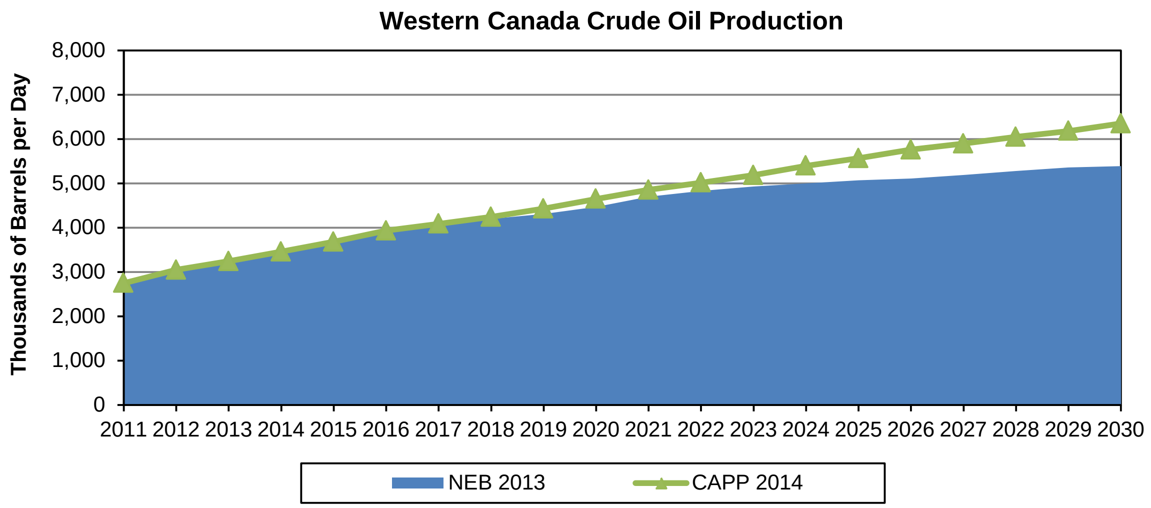


Source: NEB, CAPP

Figure 11 below provides the comparison between the NEB forecast and the most recent CAPP (2014) forecast.[21] The forecasts are similar through about 2024. At the end of the forecast period in 2030, the NEB total crude oil production volume is about 15 percent less than that of CAPP. The 2014 CAPP crude oil supply forecast is the one that is used for market analysis discussed earlier in this report.

[21] The CAPP report is: *Crude Oil: Forecast, Markets & Transportation*, June 2014.

Figure 11



Source: NEB, CAPP

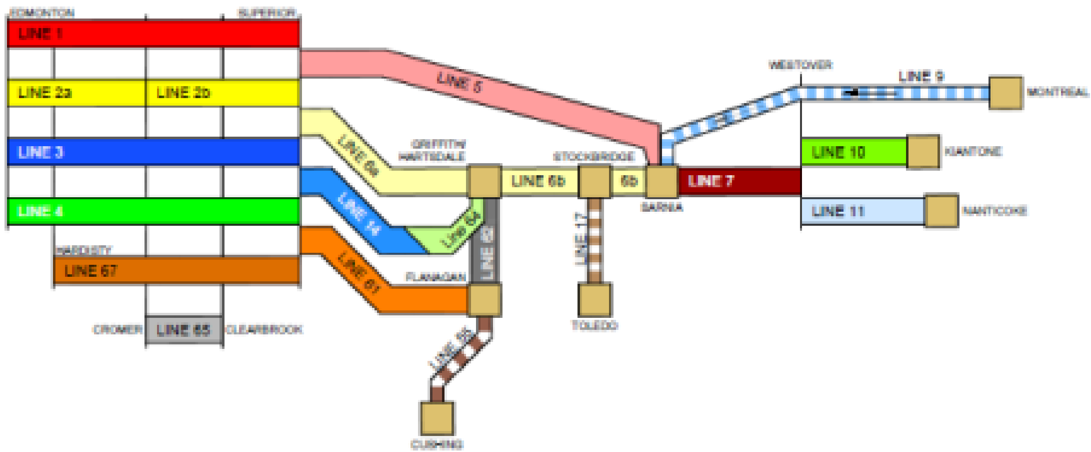
In summary, the CAPP and NEB forecasts differ in the details, but more broadly communicate the same message — the forward outlook for Western Canada is one of very large increases in crude oil supply. As a practical matter, such increases must be transported to the market by some combination of pipeline and rail. The Project represents a small portion of the transportation capacity that will have to be utilized over the next decade.

APPENDIX 1

Pipeline System Configuration

Quarter 1, 2013

ENBRIDGE



Line 1
37,600 m³/d (236.5 kbpd)
18"/20" - 1098 miles
NGL
Refined Products
Light Synthetics

Line 2
Line 2a
70,300 m³/d (442.2 kbpd)
24" - 596 miles
Line 2b
70,300 m³/d (442.2 kbpd)
24"/26" - 502 miles
Condensates
Light Synthetics
Sweet
Light & High Sour

Line 3
62,000 m³/d (390.0 kbpd)
34" - 1098 miles
Condensates (Edmonton to Hardisty)
Light Synthetics
Sweet
Light & High Sour

Line 4
126,500 m³/d (795.7 kbpd)
36"/48" - 1098 miles
Heavy
Medium (Ex-Clearbrook)
Light Sour (Ex-Clearbrook)

Line 5
78,100 m³/d (491.2 kbpd)
30" - 645 miles
NGL
Light Synthetics
Sweet
Light & High Sour

Line 6
Line 6a
106,000 m³/d (666.7 kbpd)
34" - 467 miles
Line 6b
45,000 m³/d (283.0 kbpd)
30" - 293 miles
Light Synthetics (Superior to Lockport)
Sweet (Superior to Lockport)
Light & High Sour
Medium
Heavy

Line 7
23,900 m³/d (150.3 kbpd)
20" - 120 miles
Light Synthetics
Sweet
Light & High Sour
Medium
Heavy

Line 65
29,500 m³/d (185.6 kbpd)
20" - 313 miles
Light Sour
Medium

Line 10
11,800 m³/d (74.2 kbpd)
12"/20" - 91 miles
Light Synthetics
Sweet
Light & High Sour
Medium
Heavy

Line 11
18,600 m³/d (117.0 kbpd)
16"/20" - 47 miles
Condensates
Light Synthetics
Sweet
Light & High Sour
Medium
Heavy

Line 62
20,700 m³/d (130.2 kbpd)
22" - 75 miles
Heavy

L 14 / L 64
50,500 m³/d (317.6 kbpd)
24" - 467 miles
Light Synthetics
Sweet
Light & High Sour
Medium

Line 61
63,600 m³/d (400.0 kbpd)
42" - 454 miles
Light Synthetics
Sweet
Light & High Sour
Medium
Heavy

Line 67
71,500 m³/d (449.7 kbpd)
36" - 999 miles
Heavy

Not Part of the Enbridge Mainline System

Line 9
38,200 m³/d (240.3 kbpd)
30" - 524 miles
Condensates
Sweet
Medium
Light & High Sour

Line 17
16,000 m³/d (100.6 kbpd)
16" - 88 miles
Heavy

Line 55
30,700 m³/d (193.3 kbpd)
22"/24" - 575 miles
Light Synthetics
Sweet
Light & High Sour
Medium
Heavy

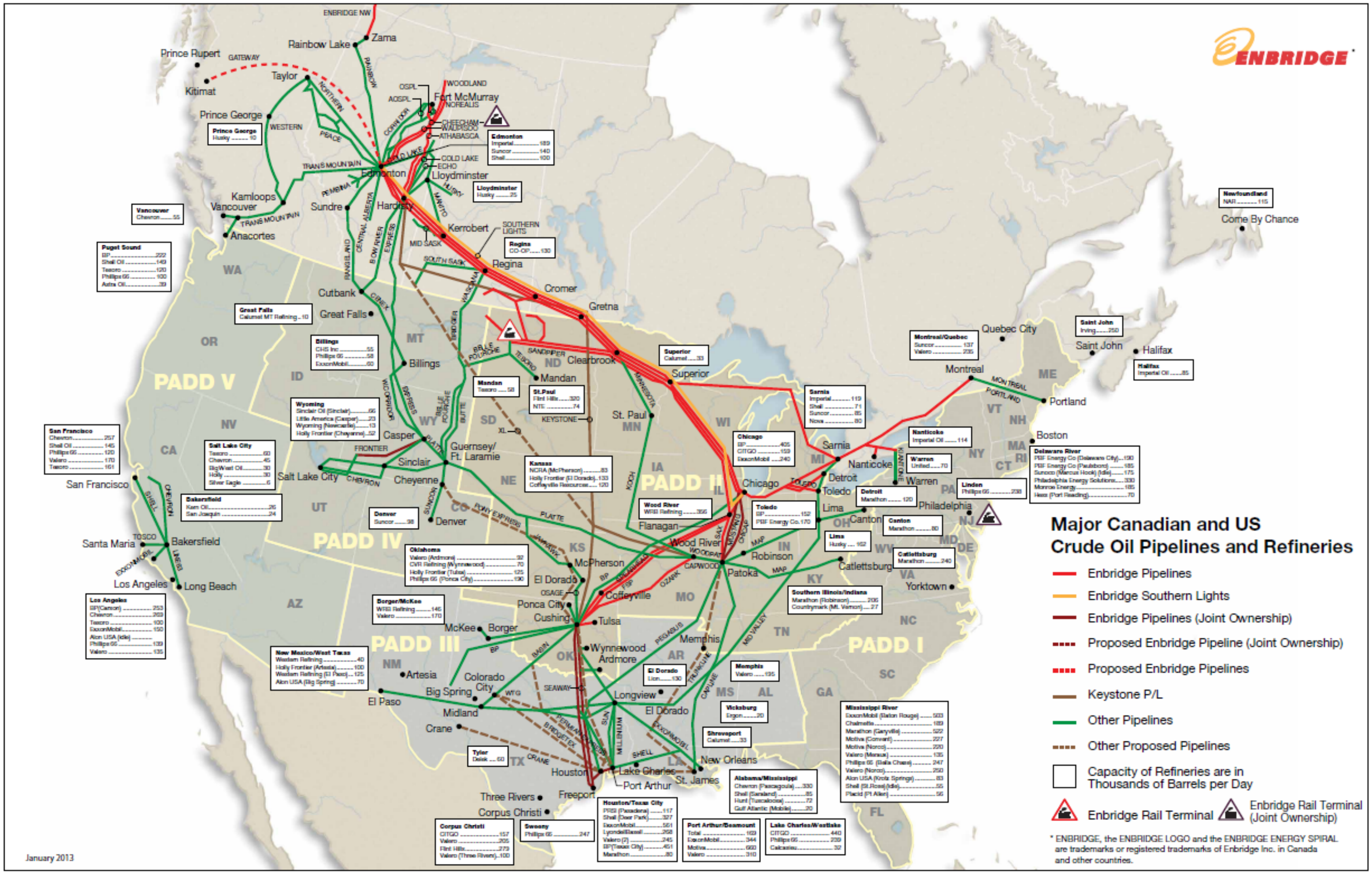
NOTES:

Capacities provided are Annual Capacities and do not include current restrictions.

- Updated: January 2013
File: 2013_Q1 System Config.dwg

Revised by: YZ
Drawn by: DRD

APPENDIX 2


ENBRIDGE
Major Canadian and US Crude Oil Pipelines and Refineries
Enbridge Pipelines
Enbridge Southern Lights
Enbridge Pipelines (Joint Ownership)
Proposed Enbridge Pipeline (Joint Ownership)
Proposed Enbridge Pipelines
Keystone P/L
Other Pipelines
Other Proposed Pipelines
Capacity of Refineries are in Thousands of Barrels per Day
Enbridge Rail Terminal
Enbridge Rail Terminal (Joint Ownership)
* ENBRIDGE, the ENBRIDGE LOGO and the ENBRIDGE ENERGY SPIRAL are trademarks or registered trademarks of Enbridge Inc. in Canada and other countries.
January 2013
PADD V
PADD IV
PADD III
PADD II
PADD I
Zama
Rainbow Lake
Prince Rupert
Kitimat
Taylor
Prince George
Fort McMurray
Edmonton
Lloydminster
Hardisty
Kerrobert
Regina
Cromer
Gretna
Kamloops
Vancouver
Anacortes
Sundre
Cutbank
Great Falls
Billings
Clearbrook
Mandan
Superior
St. Paul
Casper
Sinclair
Guernsey/ Ft. Laramie
Salt Lake City
Cheyenne
Denver
San Francisco
Santa Maria
Bakersfield
Los Angeles
Long Beach
McPherson
El Dorado
Ponca City
Coffeyville
Cushing
Tulsa
Wynnewood
Ardmore
McKee
Borger
Artesia
El Paso
Big Spring
Colorado City
Midland
Crane
Longview
Houston
Lake Charles
Port Arthur
St. James
New Orleans
Three Rivers
Corpus Christi
Freeport
Memphis
Flanagan
Wood River
Patoka
Robinson
Chicago
Toledo
Detroit
Lima
Canton
Sarnia
Nanticoke
Warren
Philadelphia
Catlettsburg
Yorktown
Montreal
Quebec City
Portland
Boston
Saint John
Halifax
Come By Chance