CRUDE OIL BY RAIL: PART I
POTENTIAL FOR THE MOVEMENT OF ALBERTA OIL SANDS CRUDE OIL AND RELATED PRODUCTS BY CANADIAN RAILWAYS

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There is a very significant current interest in the enormous potential in Canada from the future development of energy sources such as the Alberta oil sands. The crude oil from these sources is traditionally transported to markets by pipeline. However, the large quantities of product involved will require the development of new transmission pipeline capacity, and there is controversy over the construction of new transmission pipelines such as the northern gateway and the keystone XL pipelines.

While these controversies get resolved, there is a potential for the movement of crude oil and related products by Canadian railways. This two-part paper will provide a broad overview of these issues, including the current movement of crude oil and related traffic and approximate estimates of the rail capacity to handle future volumes.

The Alberta Oil Sands

The Canadian oil sands are situated entirely in Alberta in three distinct locations – the Athabasca, Cold Lake and Peace River oil sands (see Figure 1). A schematic of the oil sands taken from a primer written by the Energy Policy Research Foundation Inc. [1] is presented in Figure 2 that identifies some of the principal characteristics. The following points may be noted:

- The vast volume of recoverable barrels of oil at an extraction rate of 5 million barrels per day (b/d) would last over 90 years;
- In situ methods of extraction – which involve drilling to greater depths – will eventually recover some 80% of the oil, with land disturbance only slightly more than conventional oil;
- Mining extraction is limited to the Athabasca oil sands, with land disturbance over an area equivalent to a square footprint with sides of only 15 miles.

Figure 1

The immediate product of the oil sands is bitumen and since it is a very viscous oil it must either be upgraded into synthetic crude oil (SCO) or mixed with a diluent so it can flow down a pipeline. In situ produced bitumen is typically mixed with a diluent; mined bitumen is typically upgraded to SCO.

The focus of this paper will be the outbound movement of the SCO and diluted bitumen – also referred to as blended bitumen, dilbit, or just crude oil – but also to a lesser extent the inbound movement of diluent.

The predominant movement of outbound product is by liquid pipeline. As indicated by the Canadian Energy Pipeline Association [2]:

> Producing oil fields commonly have a number of small diameter **gathering** lines that gather crude oil from the wells and move it to central gathering facilities called oil batteries. From here, larger diameter **feeder** pipelines transport the crude oil to nearby refineries and to long-haul pipelines. The largest pipelines, called **transmission** lines, transport crude oil and other liquids across the country.[2]

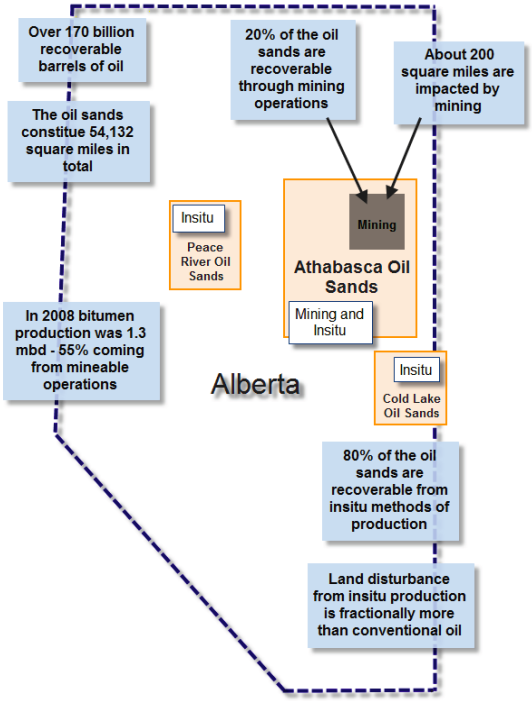

Figure 2

The important point here is that there is no direct rail service into the oil sands, and all the outbound product is initially transported by gathering and feeder pipelines. Figure 3 is taken in part from the Canadian National (CN) website [3] and shows some of the Athabasca and Cold Lake oil sands project sites as well as the CN rail line to Fort McMurray. While it may appear that CN provides direct rail service, in fact many of the Athabasca sites are north of the Athabasca River, and it would need a rail bridge across this river that has a prohibitive cost estimate of several hundred million dollars in order for CN to provide direct rail service. Neither does CP provide direct rail service into the oil sands, but it does have rail service at Edmonton and the Alberta Industrial Heartland location northeast of

Edmonton, as well as service at Hardisty, Alberta, as will be seen below. Both of these locations are the termini of the feeder pipelines.

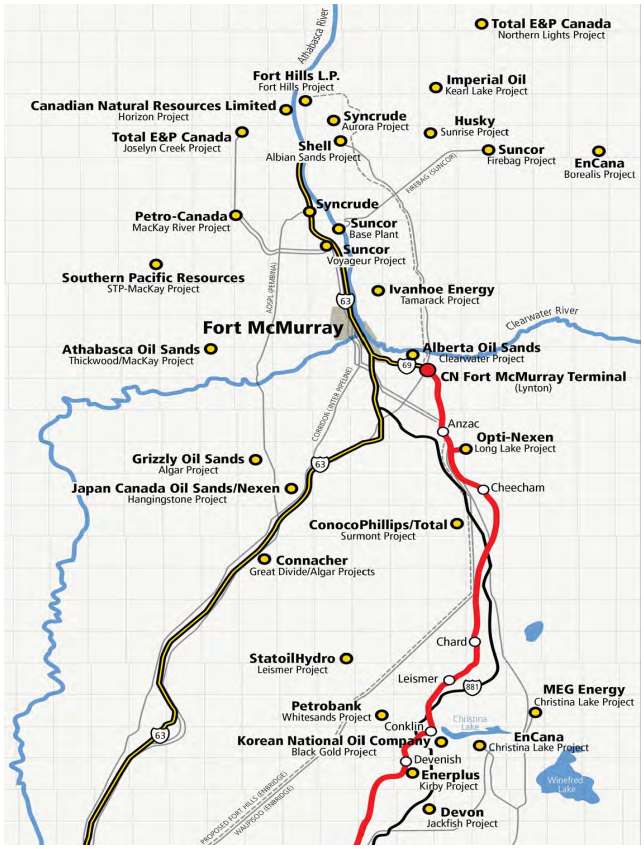

Figure 3

In order to better understand the operations of the feeder pipeline network, Figure 4 presents an approximate summary of the various feeder pipeline companies, their pipelines and locations, the product carried, and their capacities. The following points may be noted:

EXHIBIT 4

Company	Feeder Pipeline Name	Origin	Destination	Length (km)	Product	Shipper	Capacity (b/d)
ENBRIDGE							
	Athabasca	Fort McMurray	Hardisty	540	Crude Oil		570,000
	Athabasca Twinning	Cold Lake (Christiana Lake)	Hardisty	345	Crude Oil	Cenovus	450,000-800,000
	Waupisoo	Cheecham (70km south of Ft M)	Edmonton	380	Crude Oil		600,000
	Waupisoo Expansion	Cheecham (70km south of Ft M)	Edmonton	380	Crude Oil		65,000-255,000
	Woodland	Fort McMurray (Kearl Lake)	Cheecham (70km south of Ft M)	140	Blended Bitumen	Imperial Oil	200,000
INTER PIPELINE							
35%	Corridor	Fort McMurray	Edmonton (Scotford)	500	Diluted Bitumen	Shell/Chevron/Marathon	296,000
	Cold Lake	Cold Lake (La Corey)	Edmonton	250	Blended Bitumen	Cenovus/CNRL/Imperial Oil	490,000
		Cold Lake (Foster Creek)	Hardisty	320	Blended Bitumen	and Shell	
	Cold Lake Expansion	Cold Lake (Narrows Lake)	Cold Lake (Foster Creek)	85	Blended Bitumen	Cenovus	190,000
		Cold Lake (Foster Creek)	Cold Lake (La Corey)	80	Blended Bitumen	Cenovus	710,000
		Cold Lake (La Corey)	Hardisty	240	Blended Bitumen	Cenovus	540,000
	Polaris	Edmonton (Scotford)	Fort McMurray (Muskeg River)	460	Diluent		90,000
	Polaris Expansion	Edmonton	Cold Lake (Christina Lake)	240	Diluent		700,000
		Cold Lake (Christina Lake)	Cold Lake (Foster Creek)	75	Diluent		120,000
		Cold Lake (Christina Lake)	Cold Lake (Narrows Lake)	20	Diluent		55,000
PEMBINA							
30%	Syncrude	Fort McMurray (Syncrude)	Edmonton	500	Synthetic Crude Oil	Syncrude	389,000
	Horizon	Fort McnMurray (CNRL)	Edmonton	550	Synthetic Crude Oil	CNRL	250,000
	Cheecham Lateral	Syncrude pipeline outlet	Cheecham	56	Synthetic Crude Oil	Conoco/Total/Nexen/CNOOC	136,000
	Nipisi	Peace River (Seal)	Edmonton	190	Diluted Bitumen	CNRL/Cenovus	100,000
	Mitsue	Edmonton	Peace River (Seal)	255	Diluent	CNRL/Cenovus	22,000
ACCESS							
	Access (1)	Edmonton	Cold Lake (Christiana/Jackfish)	345	Diluent	MEG Energy/Devon	na
	Access (2)	Cold Lake (Christiana/Jackfish)	Edmonton	345	Blended Bitumen	MEG Energy/Devon	na
	Northeast Expansion	Cold Lake (near Conklin)	Edmonton	297	Blended Bitumen		350,000
SUNCOR							
	Firebag	Fort McMurray (Firebag project)	Fort McMurray (Suncor base plant)	40	Diluted Bitumen	Suncor	368,000

Sources: Various industry websites

Figure 4

- Most of the feeder pipelines move SOC or blended bitumen southbound and diluent northbound, although there are some pipeline segments that move product laterally within the oil sands region;
- There are only two locations that are the destinations for the southbound movements – Edmonton and the Alberta Industrial Heartland to the north east, and Hardisty, which is a location some 200 km to the southeast of Edmonton;
- The capacities of the feeder pipelines are estimates of the current maximum capacities. However, these capacities vary with the product – the flow rate for SCO will differ from the

heavier blended bitumen, for example. Moreover, the situation is more complicated if the pipeline is segmented, and overall the figures may only be taken as approximate;[3]

- Interline pipeline indicates that its current total southbound capacity of 786,000 b/d represents 35% of the total of all feeder pipelines, while Pembina indicates that its current total southbound capacity of 639,000 b/d represents 30% of the total of all feeder pipelines. While these figures do not agree precisely they suggest that the total current southbound feeder capacity is a little over 2 million b/d.

EXHIBIT 5

Company	Transmission Pipeline Name	Origin	Destination	Length (km)	Product	Capacity (b/d)
I EXISTING						
ENBRIDGE						
	Enbridge and Lakehead System	Edmonton and Hardisty	Montreal, US mid-west, Cushing Oklahoma and US Gulf Coast	5,363	Crude oil, Natural Gas Liquids and Refined Petroleum	2,500,000
	Southern Lights	Manhatten, Illinois	Edmonton	1,086	Diluent	180,000
KINDER MORGAN						
	Trans Mountain	Edmonton	Burnaby, BC and Washington State	1,150	Crude oil and Refined Petroleum	300,000
	Express	Hardisty	Casper, Wyoming	1,263	Crude oil	280,000
	Platte	Casper, Wyoming	Wood River, Ilinois	1,500	Crude oil	164,000
TRANSCANADA						
	Keystone - Phase 1	Hardisty	Steele City, Nebraska and Wood River, Illinois	3,456	Crude oil	590,000
	Keystone - Phase 2	Steele City, Nebraska	Cushing, Oklahoma	480		
II PROPOSED NEW AND EXPANSIONS						
ENBRIDGE						
	Northern Gateway	Edmonton	Kittimat, BC for offshore	1,177	Crude oil	525,000 - 850,000
		Kittimat, BC	Edmonton	1,177	Diluent	193,000
KINDER MORGAN						
	Trans Mountain expansion	Edmonton	Burnaby, BC and Washington State	900	Crude oil	450,000
TRANSCANADA						
	Keystone XL - Phase 4	Hardisty	Steele City, Nebrasca	1,897	SCO and blended bitumen	830,000
	Keystone XL - Phase 3	Cushing, Oklahoma	Houston, Texas	856		

Sources: Various Industry websites

Figure 5

The building of new oil sands feeder pipelines, or the expansion of the existing pipelines, requires the regulatory approval of the Energy Resources Conservation Board (formerly the Alberta Energy and Utilities Board) and this agency, dealing with matters entirely within Alberta, are likely to give less consideration to interference from political and environmental interests outside the Province.

Turning now to the transmission pipelines that move product between Edmonton/Hardisty and markets across the continent and overseas, Figure 5 presents an approximate summary of the various trans-mission pipeline companies, their existing pipelines and locations, the product carried, and their capacities – together with some of the proposals for new pipelines or the expansion of existing pipelines. The following points may be noted:

- Enbridge has a comprehensive existing system that takes crude oil from Edmonton and Hardisty east to Montreal and south as far as the US Gulf coast, with a total capacity of 2.5 million b/d. It also has a northbound pipeline from Illinois to Edmonton that brings in diluent;
- Enbridge has plans for a northern gateway system that would take crude oil from Edmonton to Kittimat, BC, for shipment offshore, with an initial capacity of 525,000 b/d rising to 850,000 b/d. This system also includes a pipeline from Kitti-mat to Edmonton for diluent with a capacity of 193,000 b/d;
- Kinder Morgan has the trans-mountain pipeline that takes crude oil from Edmonton to Burnaby, BC, and to Ferndale and Anacortes on the coast of Washington State, with an existing capacity of 300,000 b/d. It has plans to expand the trans mountain pipeline along the existing right-of-way to provide an additional capacity of 450,000 b/d;
- Kinder Morgan also has the express and platte pipeline systems that takes crude oil from Hardisty south to Casper, Wyoming, and then east to Wood River, Illinois; the first segment has a capacity of 280,000 b/d and the second segment 164,000 b/d;
- TransCanada has the keystone system that may be described in four phases as identified in Figure 6 taken from [4]. The

existing phase 1 moves crude oil from Hardisty south to Steele City, Nebraska, and then east to Wood River, Illinois. The existing phase 2 moves crude oil from Steele City to Cushing, Oklahoma. Phases 1 and 2 have a combined capacity of 590,000 b/d;

- TransCanada has plans for new keystone XL pipelines. Phase 3 that is currently under construction will move crude oil from Cushing to Houston, Texas. Phase 4 would move crude oil over a new route from Hardisty to Steele City – this is the controversial phase that has received approval from the Governor of Nebraska, but at time of writing still requires approval from the US federal government. If completed, keystone XL would have a combined capacity of 830,000 b/d.

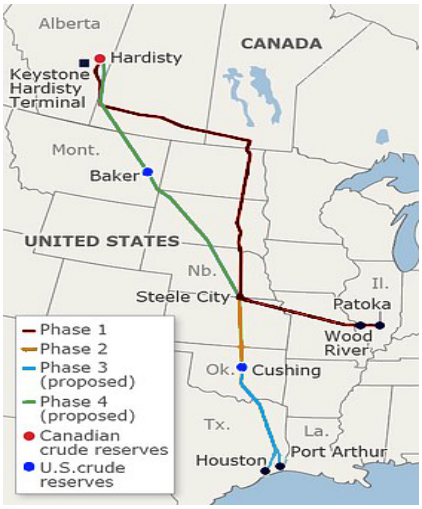

Figure 6

Overall, the total transmission pipeline existing capacity for the continental movement of crude oil from Edmonton and Hardisty – keeping clearly in mind that conventional crude oil, refined petroleum and other products also use this pipeline network – is some 3.5 million b/d. If all the new and expansion projects were completed, an

additional capacity of some 2 million b/d would become available. For the inbound movement of diluent, the existing capacity is 180,000 b/d with plans for an additional 193,000 b/d.

Finally, to complete this section Figure 7 presents the current storage capacity in millions of barrels for selected companies at facilities in the Edmonton area and Hardisty

EXHIBIT 7	Storage Capacity	
	HARDISTY	EDMONTON
	(milions of barrels)	
ENBRIDGE		
Cavern Storage	3.1	
Surface Stoage Facility	7.5	
TRANSCANADA	2.6	
KINDER MORGAN		4.5
INTER PIPELINE		3.5
PEMBINA		>0.3
Source: Various Industry websites		

Figure 7

Outlook for the Production of Crude Oil from Alberta Oil Sands

In Figure 8 is presented the outlook to 2035 for the production of crude oil from the Alberta oil sands compiled by the National Energy Board in its energy market assessment dated November 2011 [5]. The assessment makes the following comments:

> Oil sands production forecasts released by the Canadian Association of Petroleum Producers (CAPP) and the Energy Resources Conservation Board (ERCB) are shown. In 2020, the ERCB projection is about six per cent higher than the NEB Reference Case, while CAPP is about two per cent higher.
>
> By 2035, in the Reference Case, oil sands bitumen production is projected to reach 5.1 million b/d, three times the production for 2010. The majority of the growth occurs in the in situ category.

In situ projects are smaller and less expensive to build so the cost of entry is lower. Also, 80 per cent of the oil sands reserves are considered well suited to in situ extraction, versus 20 per cent for mining methods.

Over the longer-term, the list of currently proposed projects, many of which are in the early planning stage, suggest that bitumen production could reach 8.3 million b/d.

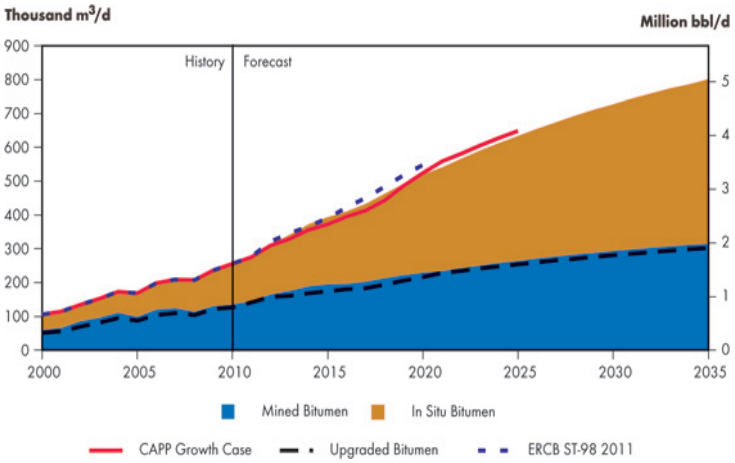

Figure 8. Oil Sands Production, NEB Reference Case

A close inspection of Figure 8 suggests that the NEB were projecting a figure of perhaps 2 million b/d in 2012. The same NEB report suggests that the production of conventional crude oil in 2012 would result in some 1 million b/d. Later estimates provided by the Canadian Association of Petroleum Producers (CAPP) [6] indicate that oil sands production will rise from 1.6 to 2.3 million b/d between 2011 and 2015, and that conventional production will rise from 1.1 to 1.3 million b/d over the same time period. Given the uncertainty of such projections and estimates it is not surprising that, at time of writing, media reports suggest that the actual total crude production has run up against the transmission pipeline capacity constraint.[4]

The increasing supply of crude oil and the associated tightening of pipeline capacity has resulted in a gap developing between the West Texas Intermediate price received by oil sands producers and the global Brent price. The National Energy Board [7] has described commodity price changes as follows:

> When there is adequate pipeline capacity between two market hubs, commodity prices will be connected and the price differential will be equal to, or less than, the transportation costs between the two points. As long as the price differential is less than the toll, the market is indicating that there is adequate pipeline capacity between the two pricing points. Where inadequate capacity exists, the product cannot get to market, resulting in higher prices for downstream consumers or lower revenues to producers, creating a higher differential in price between the two end points.

The current price discounting began in early 2011 and at time of writing has reached $20 per barrel [8]. Several media commentators are also suggesting the discount has spiked to between $37 and $40 per barrel. Cenovus is quoted as suggesting a discount of $28 per barrel in 2013, and in [8] longer-term projections are stated as follows:

> Under the current futures market pricing the differential between Brent and WTI narrows over the next few years, falling below $9 per barrel in 2015 and below $5 per barrel by 2019. However, the futures price could be misleading, as investors have likely assumed the approval and future completion of keystone XL and/or a west coast pipeline, which is why the spread declines over time. If pipeline capacity is not increased, spreads will likely remain much higher.

One important implication of continuing price discounts is the possibility of a scaling back of oil sands production, and the postponement or cancellation of new production projects. However, part II of this paper will focus instead on the opportunities for Canadian railways to handle a significant volume of the oil sands production of crude oil, and the economics of such movements.

References

[1] Energy Policy Research Foundation Inc. Washington, DC, November 2010.

[2] Canadian Energy Pipeline Association, at www.cepa.com/about-pipelines/types-of-pipelines/liquids-pipelines

[3] Canadian National railway at www.cn.ca/documents/Investor-Factbook-current/2011-IFB-Markets-en.pdf

[4] http://en.wikipedia.org/wiki/Keystone_Pipeline

[5] National Energy Board, Canada's Energy Future, Energy Supply and Demand Projections to 2035, An Energy Market Assessment, November 2011.

[6] Canadian Association of Petroleum Producers, Crude Oil Forecast, Markets and Pipelines, June 2012.

[7] National Energy Board, Canadian Pipeline Transportation System, Transportation Assessment, July 2009.

[8] TD Economics, Pipeline Expansion is a National Priority, December 2012.

Endnotes

[1] Malcolm Cairns, formerly with CP, is sole proprietor of Malcolm Cairns Research and Consulting.

[2] This description is reminiscent of freight rail, where a producing plant may have some local tracks in the plant served by a plant locomotive, which delivers loaded and empty cars to and from a siding. Then a shortline railway might take the cars to an interchange with a main line railway such as CP or CN for furtherance to markets across the continent.

[3] This is again reminiscent of freight rail, where a density map of traffic by rail line segment varies by segment and by direction.

[4] It is also probable that the feeder pipelines from the Alberta oil sands are also near or at full utilization.