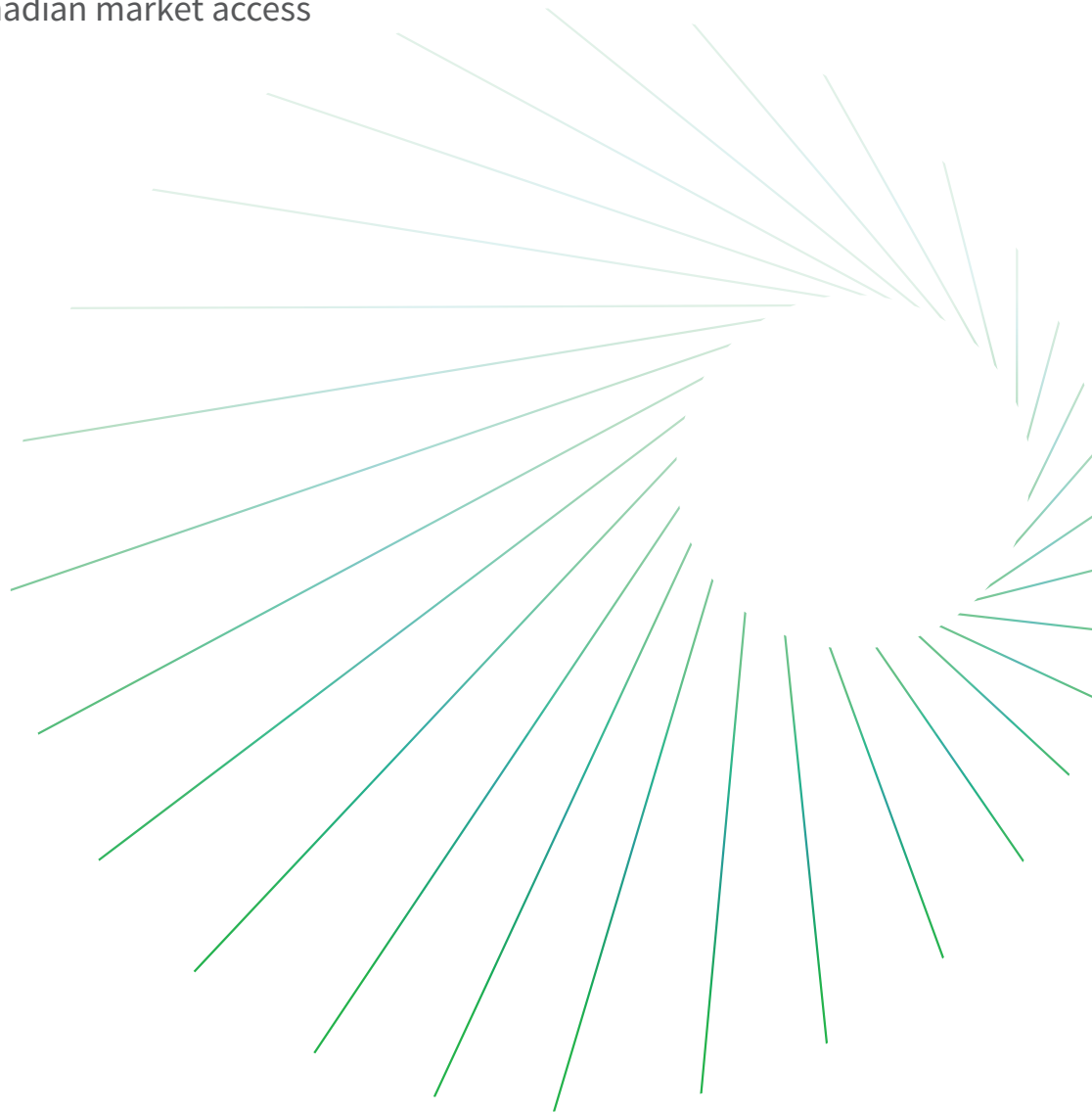


# Pipelines, Prices, and Promises

The story of western Canadian market access

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# Pipelines, Prices, and Promises

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### About this report

**Purpose.** Since 2009, IHS Markit has made public research on issues surrounding the development of the Canadian oil sands. As western Canadian production has increased, it has at times overtaken available pipeline takeaway capacity, reducing the price that producers have been able to obtain for their crude oil. Pipeline projects have been proposed to move increasing volumes to market, but they have also met opposition and ultimately delay. This report explores the status of western Canadian pipeline capacity, demand, and supply and the promise of advancing pipelines.

**Context.** This report is part of a series of reports from the IHS Markit Canadian Oil Sands Dialogue. The dialogue convenes stakeholders in the oil sands to participate in an objective analysis of the benefits, costs, and impacts of various choices associated with Canadian oil sands development.

This report and past Oil Sands Dialogue reports can be downloaded at [www.ihs.com/oilsandsdialogue](http://www.ihs.com/oilsandsdialogue).

**Methodology.** IHS Markit conducted its own extensive research and analysis on this topic, both independently and in consultation with stakeholders. IHS Markit has full editorial control over this report and is solely responsible for its content (see the end of the report for the IHS Markit team).

**Structure.** This report has three sections.

Part 1: Western Canada has become accustomed to price volatility

Part 2: A history of pipeline delay

Part 3: New pipeline capacity on the horizon, but growth of crude by rail also expected

# Pipelines, Prices, and Promises

## The story of western Canadian market access

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### Key implications

The history of pipeline proposals, particularly those from western Canada, has been tumultuous. Various pipeline projects have been proposed, approved, overturned, denied, and—more recently—revived. At times, pipeline capacity from western Canada has been constrained, and the price of oil in western Canada has fallen well below that of global peers. This report explores the relationship between pipelines and prices, the current state of pipeline proposals, and the outlook for this relationship. It focuses on what has become a top concern—the building of the infrastructure necessary to connect growing supply to markets.

- **Transportation cost is a key reason why oil prices differ among regions.** Although variations in quality, such as light versus heavy oil, result in price differences among various crude oils, transportation costs contribute to price differences among regions for crude of similar quality.
- **Transportation constraints have, in the past, contributed to price volatility and a loss of economic value for western Canadian producers.** Pipeline constraints have contributed to price volatility for western Canadian producers and a rise of crude by rail. At times, price discounts were severe, which incentivized investments in new pipeline takeaway capacity from western Canada.
- **The average pipeline review process, from application to early 2017, has spanned more than five years, with no major additions constructed in recent years.** The processes have spanned more than eight years for the Keystone XL pipeline; more than six years for Northern Gateway; more than four years for the Alberta Clipper Expansion; more than three years for the Trans Mountain Expansion; and two years for Energy East, which is still in the early days. This does not include the time prior to application for business development and for front-end engineering and design.
- **Western Canada has the potential to move from a pipeline capacity shortfall to surplus.** If all pipelines advance as announced, nearly 2.9 MMB/d of new takeaway capacity could be added—sufficient to meet growing Canadian supply for some time.
- **Although there is a new sense of pipeline optimism, none of the proposed projects are done deals.** Pipeline projects remain controversial and will likely face ongoing challenges from opposition and litigation.

## Western Canada has become accustomed to price volatility

Western Canadian oil producers are landlocked, with nearly all exports sold to the United States via long-distance overland pipelines. With output destined to rise over the next few years, building pipelines—the infrastructure required to connect supplies with buyers—is of the utmost importance for western Canada.

Prices in western Canada track global markets but at a price that reflects the cost of transport to the greatest source of demand. This has historically been via pipeline to the US Midwest. When transportation has been functioning efficiently and without constraints, western Canadian heavy oil has tracked within roughly \$8/bbl of globally traded crudes of similar quality, such as Mexican Maya.<sup>1</sup> For more information on the factors that contribute to price differences among regions, please see the box “Primer: Oil price differences among regions.”

However, the price of crude oil in western Canada has, for some periods, been discounted much more dramatically than globally traded crudes. In the past, transportation system bottlenecks have occurred, causing crude oil to become trapped until it could clear the market through higher-cost forms of transport.

For example, during a five-month period from November 2012 through March 2013, WCS obtained approximately \$30/bbl less than Mexican Maya (see Figure 1). During this period, western Canadian heavy oil production averaged nearly 1.7 MMb/d, which would equate to about \$6 billion in lost revenue over just this period.<sup>2</sup> As Figure 1 shows, in recent years there have been multiple periods of reduced prices.

### Primer: Oil price differences among regions

The price of crude oil—a globally traded commodity—tracks from region to region. However, price differences among regions do exist. This has been an area of particular interest in western Canada, where oil prices are lower than those of globally traded peers. There are two often cited reasons why oil prices may differ between regions: transportation and crude quality. However, only transportation results in price differences for similar quality crudes between regions.

**Transportation.** Transportation connects oil-producing regions to consumers. The cost of transport, which can vary by distance and/or mode, can result in price differences for crude oil of similar quality between regions. For example, prior to the rise of inland US crude oil production, Canadian light crude competed for market share in the Chicago area with light crude oil from the US Gulf Coast region. From 2006 to 2010, before US tight oil changed inland relationships, the cost of western Canadian light crude oil in the Chicago area priced within \$2–3 of similar crude from the US Gulf Coast despite the 2,300 miles between these two producing regions.\*

**Quality.** Another reason for oil price differences is crude quality. Although in principle substitutable, crude oil is not homogenous. Crude quality is often distinguished by density, viscosity, and impurities. In a general sense, less dense, or “lighter,” crude oils are more easily converted into refined products such as gasoline and diesel. “Heavier,” or higher-density, crudes are more costly to convert into refined products. Impurities, such as sulfur, must be removed during the refining process to meet product specifications. The greater the sulfur level (and/or other impurities), the higher the cost to process the crude oil. Low-sulfur crudes (less than 1%) are called “sweet,” while high-sulfur crudes are “sour.” Sulfur is the most commonly cited impurity, but others, such as heavy metals or acids, also exist. Generally, the heavier and more sour the crude, the more energy that is required for refining and the lower the value refiners will place on the crude. For example, Mixed Sweet Blend (MSW) and Western Canadian Select (WCS) are two crude oils from Alberta, but they differ in quality. WCS is categorized as a “heavy, sour” crude whereas MSW is a “light, sweet” crude. In 2016, WCS averaged roughly \$30/bbl while MSW averaged \$41/bbl.

\*The cost of Louisiana Light Sweet (LLS), a light crude oil benchmark price indicator on the US Gulf Coast, averaged about \$78/bbl from 2006 to 2010, with the average pipeline transportation cost into the Chicago area at about \$1/bbl. By comparison, MSW, a light crude oil benchmark priced in Alberta of similar but not identical quality to LLS, averaged about \$74/bbl over the same period, with the cost of transport to the Chicago region averaging nearly \$3/bbl.

1. The estimate is based on the average range adjusted for periods with extreme outliers during 2006–16 between Western Canadian Select (WCS), a heavy crude oil benchmark in western Canada, and Mexican Maya, a globally traded heavy crude oil benchmark for the US Gulf Coast.

2. This production includes conventional and heavy bitumen blend from 1 November 2012 to 31 March 2013, adjusted for transportation cost to the US Gulf Coast region.

As production growth accelerated in western Canada, a number of pipelines were proposed to resolve anticipated transportation constraints. Some of these projects have been under various stages of review since 2008. In the absence of new pipeline infrastructure, western Canada experienced increased price volatility and around 2012 producers began to turn to railroads for their product to reach market.

### Rail has proven capable of moving significant volumes

At its peak in late 2014, the North American crude-by-rail business topped 1.2 MMB/d of movements. Nearly four-fifths of these movements—or 1 MMB/d—originated in the United States, with the largest source coming from US tight oil in North Dakota.

Western Canadian movements also reached a historical high in the same period, at more than 230,000 b/d. The cost of transporting crude oil by rail has historically been higher than pipe, reducing the price of crude oil in western Canada relative to other crudes of similar quality.

### In recent years, western Canadian price differentials have narrowed

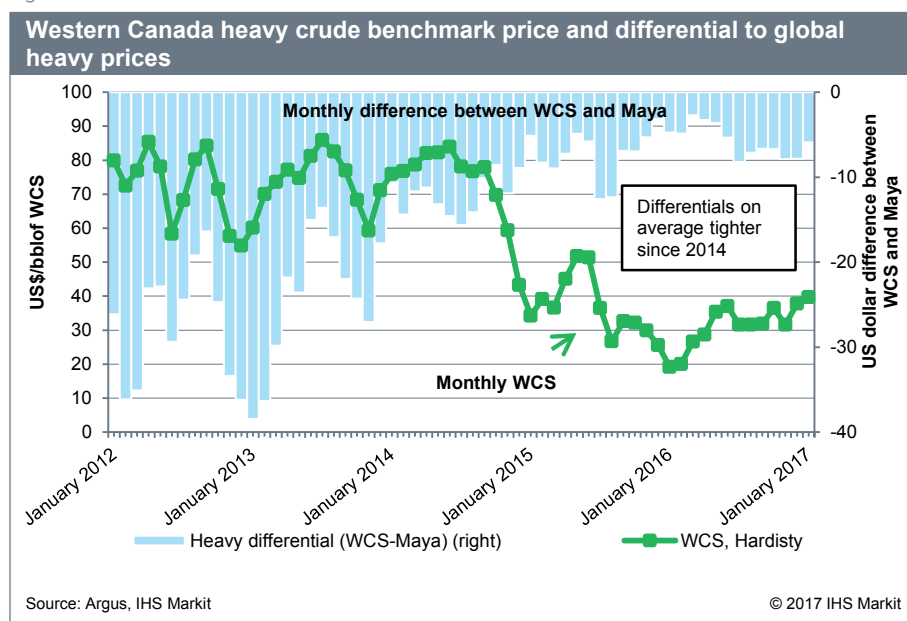
Since the price collapse of 2014–15, crude-by-rail movements have subsided, and the price difference between western Canadian heavy crude oil and globally traded crudes has diminished. There are several reasons why this has occurred:

**Conventional production declines.** From the end of 2014 to the end of 2016, conventional oil production in western Canada declined nearly 300,000 b/d. Lower oil prices reduced upstream investment, leading to a drop in conventional oil supply. This helped ease pressure on the pipeline system for rising heavy oil sands supply, which increased more than 360,000 b/d over the same period.<sup>3</sup>

**Pipeline throughput increased.** Although no new long-distance pipeline has been completed in recent years, pipeline operators have been able to increase throughput by making better use of their existing permits as well as using drag-reducing agents that can increase the flow of crude oil. For example, Enbridge was able to achieve higher export capacity on its Canadian mainline system by making use of an underutilized segment with an existing cross-border permit.<sup>4</sup>

Western Canadian volumes continue to build, and the pipeline system is expected to become increasingly constrained. Toward the end of 2016, US crude oil imports from Canada exceeded 3.5 MMB/d—the highest on record to date.<sup>5</sup> Moreover, the decline of western Canadian conventional production—which has helped offset rising heavy supply—is anticipated to slow in 2017. Western Canada supply (inclusive of imported diluents used in oil sands bitumen blends)

Figure 1



3. Conventional oil includes both light and heavy western Canadian production. Oil sands includes synthetic crude oil and bitumen blends. Estimate is based on the last three months of 2014 compared with the last two months of available data for 2016 (October to November) at the time of this report completion.

4. Alberta Clipper was brought online in 2010 with a permit to export 450,000 b/d, but design capacity since then has expanded and is capable of greater throughput. Enbridge Line 3 went into service in 1968. Since 2010, Line 3 had been operating at reduced pressure, which decreased throughput to 390,000 b/d, down from the initial export permit capacity of 760,000 b/d. In 2014, interconnections between Line 67 and Line 3 allowed Enbridge to make use of Line 3's cross-border permit capacity while maintaining lower pressure on Line 3. Enbridge has since undertaken the replacement of Line 3, which will allow it to return Line 3 to historical capacity of 760,000 b/d. However, once the Line 3 replacement is complete, Line 67 will require an amendment to its existing presidential permit to take full advantage of the expanded capacity.

5. Source: US Energy Information Administration.

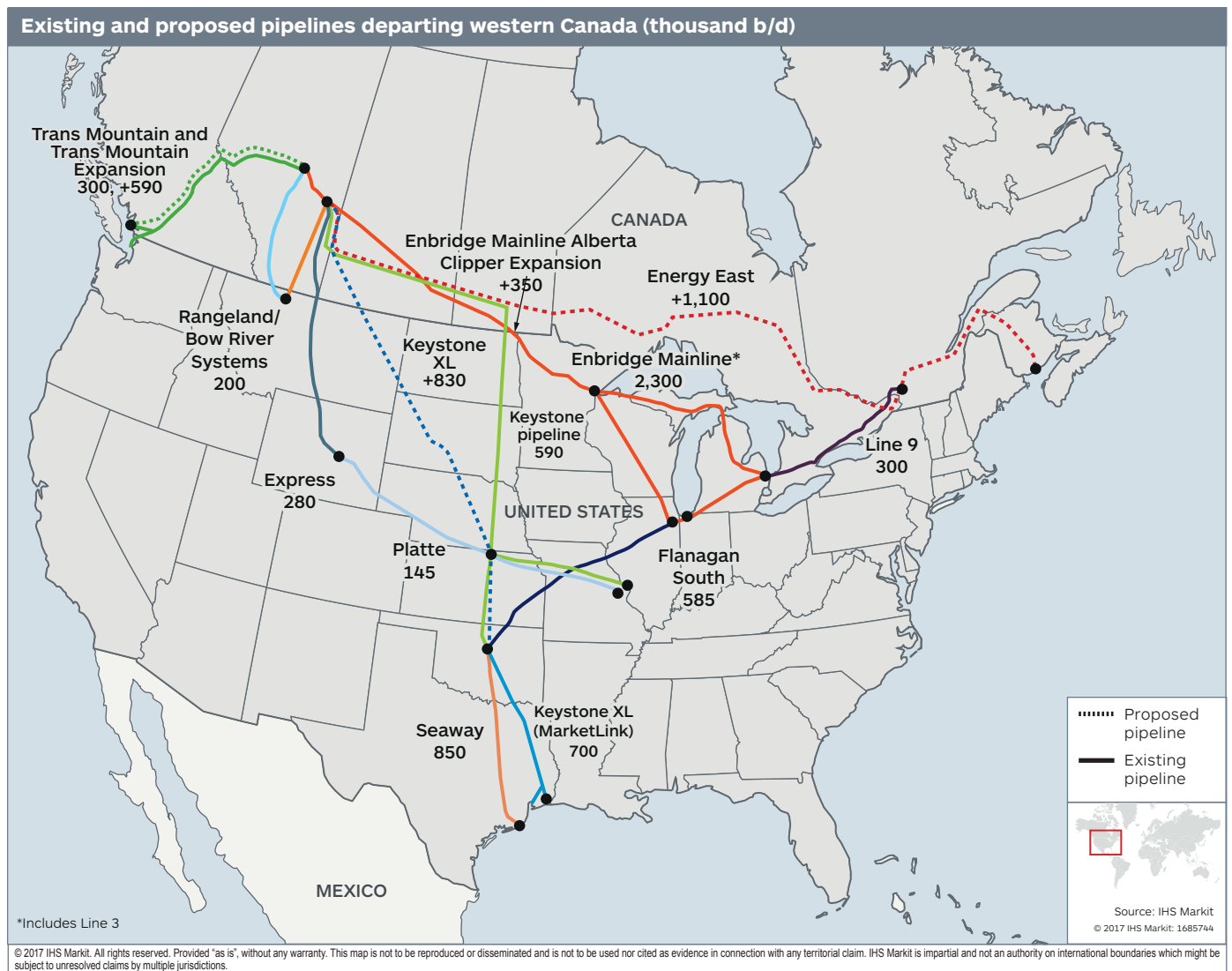
could reach 4.8 MMb/d by 2020, an increase of nearly 1 million b/d from 2016 levels. In the absence of new pipeline takeaway capacity, the system will become increasingly constrained and a resurgence of crude by rail seems likely.

## A history of pipeline delay

Several pipelines have been proposed to help resolve western Canada's pipeline constraints (see Figure 2 and Table 1). In total, nearly 2.9 MMb/d of new capacity has been proposed. Keystone XL and the Enbridge Mainline expansion would head south to the United States. The Trans Mountain Expansion would head west to Canada's coast for export into the Pacific Basin. Energy East would take western Canadian production to eastern markets and offshore. Northern Gateway was also proposed to move crude oil west, but the Canadian government denied it the necessary permit in late 2016.

Differences of opinion about the need for new pipeline infrastructure and the potential environmental and climate impacts have turned proposed pipeline projects that were once largely unknown to the public into household names and made them politically sensitive. Although it is generally agreed these factors have affected the timing of major pipeline projects, the degree and types of delay vary across projects and are not well understood.

Figure 2



## Measuring pipeline delay

Major infrastructure projects seldom proceed as planned. This has proven true for Canadian pipeline projects that span thousands of miles and take multiple years to complete. For pipelines proposed to depart western Canada, the time between applications and decisions has, for some, been extensive. Since 2010, when the Alberta Clipper and the first Keystone pipeline were commissioned, no new long-distance pipeline project departing western Canada has been successfully completed.

Pipeline projects are subject to an extensive review process (in Canada and the United States). These reviews explore the technical, economic, and environmental merits of the projects and seek ways to maximize economic value while mitigating potentially adverse environmental impacts. They aim to engage various stakeholders, including the Indigenous peoples, local communities, and others, to identify interests or concerns associated with a project. Because each pipeline project is unique, the review periods have varied, but they have always spanned multiple years. Upon completion of the review process, regulators are required to make a recommendation to the government. This can include subjecting the project to any number of conditions. Examples of conditions that can be included are when and where construction may occur, what material may be used in construction, what additional safety measures or offsets for disturbed land may be required, and how the pipeline may be operated.

Once the reviewing agencies have made their recommendation, the decision falls to the government. In the case of the United States, the State Department is both the adjudicator (lead reviewer) and the decision maker in issuing a presidential permit.<sup>6</sup> However, should differences of opinion arise during the State Department review, the president can become involved. The State Department involvement in pipelines pertains to permitting international border crossings. Multiple federal agencies are involved in reviewing and regulating interstate pipelines in the United States. Individual states also play a major role in permitting oil pipelines through their territories. In Canada, although provinces may become involved, the federal government has jurisdiction over projects transcending provincial and national boundaries. In Canada, the National Energy Board (NEB) acts as both project adjudicator and regulator, with the federal cabinet being the final decision maker on major projects.

The political decision-making process can be opaque. The high degree of public interest in pipeline projects also makes the final decision particularly sensitive for governments. Keystone XL, for example, was denied twice during President Barack Obama's administration after it received approval from Canada's NEB, only to have President Donald J. Trump invite TransCanada Corporation to reapply and then ultimately approve a cross-border permit.<sup>7</sup>

Table 1

Pipeline descriptions				
Destination	Pipeline project (proponent)	Route	Incremental capacity (b/d)	Status
US markets	Line 67 "Alberta Clipper" Expansion (Enbridge)	Hardisty, Alberta, to Superior, Wisconsin	350,000	Pending presidential permit
	Keystone XL (TransCanada)	Hardisty, Alberta, to US Gulf Coast region	830,000	Presidential permit issued, route under review by Nebraska
Eastern Canada and East Coast offshore	Energy East (TransCanada)	Hardisty, Alberta, to tidewater in Saint John, New Brunswick	1,100,000	Under regulatory review
West Coast offshore	Northern Gateway (Enbridge)	Bruderheim, Alberta, to Kitimat, British Columbia	525,000	Denied
	Trans Mountain Expansion (Kinder Morgan)	Edmonton, Alberta, to tidewater in Burnaby, British Columbia	590,000	Permitted

Source: Various sources, company releases, IHS Markit

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6. The authority to authorize cross-border permits is derived from the US Constitution, which provides the president with the responsibility for protecting the territorial sovereignty of the United States. In 1968, the president issued an executive order delegating the authority to issue border permits to the secretary of state. For more information, see the "[Interpretative Guidance on Executive Order 11423](#)," US Department of State, retrieved 1 April 2017.

7. In 2012, the State Department recommended that there was inadequate basis to make a decision given the time allotted by the US Congress. Later in 2015, the State Department did not approve the permit on the grounds that it was inconsistent with wider climate change objectives. On 24 January 2017, President Trump invited TransCanada to reapply. See the 18 January 2012 "[Statement by the President on the Keystone XL Pipeline](#)," Obama White House Archives, retrieved 22 March 2017; the 6 November 2015 "[Statement by the President on the Keystone XL Pipeline](#)," Obama White House Archives, retrieved 22 March 2017; and the "[Presidential Memorandum Regarding Construction of the Keystone XL Pipeline](#)," The White House, retrieved 30 March 2017.



Given that pipelines have failed to materialize along announced timelines, concern has been expressed that the review process has become increasingly uncertain, contentious, lengthy, and, as a result, costly. When IHS Markit examined the history of past pipeline review processes—from application to permit (and beyond)—we found that older pipeline projects (or pipelines that started earlier in the regulatory process) have indeed faced longer processes. We found insufficient evidence to conclude that there has been a material difference in time between processes involving a US presidential permit or those solely within Canada. The single-greatest source of uncertainty or lengthiest part of the process in recent years has come after regulators have made their recommendations and when elected officials needed to decide. Yet, the story on these pipelines is not over, since none have been completed and the potential for additional delay exists.

Figure 3 depicts the results of our review of timelines for the major western Canadian export-bound pipeline proposals. It is important to note that a number of factors can affect the review process. This figure captures only the key events and the timelines associated with major proposed pipeline projects departing western Canada. This summary includes Canadian federal regulatory review processes as administered by the NEB and the Government of Canada as well as the US presidential review process for pipelines transiting south to the United States. Not shown in this figure are additional regulatory processes that may be required, such as those conducted by the Federal Energy Regulatory Commission for major US pipelines and the state-level processes.

## The process does not end with a permit

A permit does not mean the end of the process. Between permitting, construction, and ultimately operation, many additional factors can affect project completion. These can include adhering to any number of conditions imposed by government, addressing public interests and interests of particular groups, and responding to requests for judicial review.

Permits are not a blank check. They are subject to oversight and typically come with a number of conditions. These conditions are put in place by regulators and the government to try to address, as best as possible, environmental, social, and economic concerns that may arise during the review process. The number of conditions can climb into the hundreds and affect the pipeline over its entire life, from construction to abandonment. For example, the Trans Mountain Expansion project approval was subject to 157 conditions.<sup>8</sup>

The courts also have a say in pipeline projects. In Canada, in addition to typical challenges to government decisions, such as pointing out shortcomings or mistakes in a process, First Nations have an additional right or special relationship with the government in which they are owed a duty to be consulted on decisions that may affect them. In the past, failure by the government to adequately consult has led to project delays, route changes, and even the loss of permits. This was the outcome of a challenge to the Northern Gateway project.

More recently, acts of civil disobedience have influenced the timing of pipelines. In North Dakota, demonstrators successfully slowed the construction of the Dakota Access Pipeline (DAPL) (the last 1,000 feet of the pipeline across the Missouri River/Lake Oahe, specifically) by raising the profile of their concerns sufficiently to get the government to delay the project.<sup>9</sup> Although the example of DAPL was recently overturned by President Trump, the demonstrations nevertheless impeded the completion of the project for a period.

Even if a project successfully moves into operation, regulators and proponents have ongoing commitments that will span the life of the project. Regulators have an obligation to monitor the project to ensure compliance with conditions and required operating procedures. Operators have obligations to consult and work with communities along project routes over the project's life.

## New pipeline capacity on the horizon, but growth of crude by rail also expected

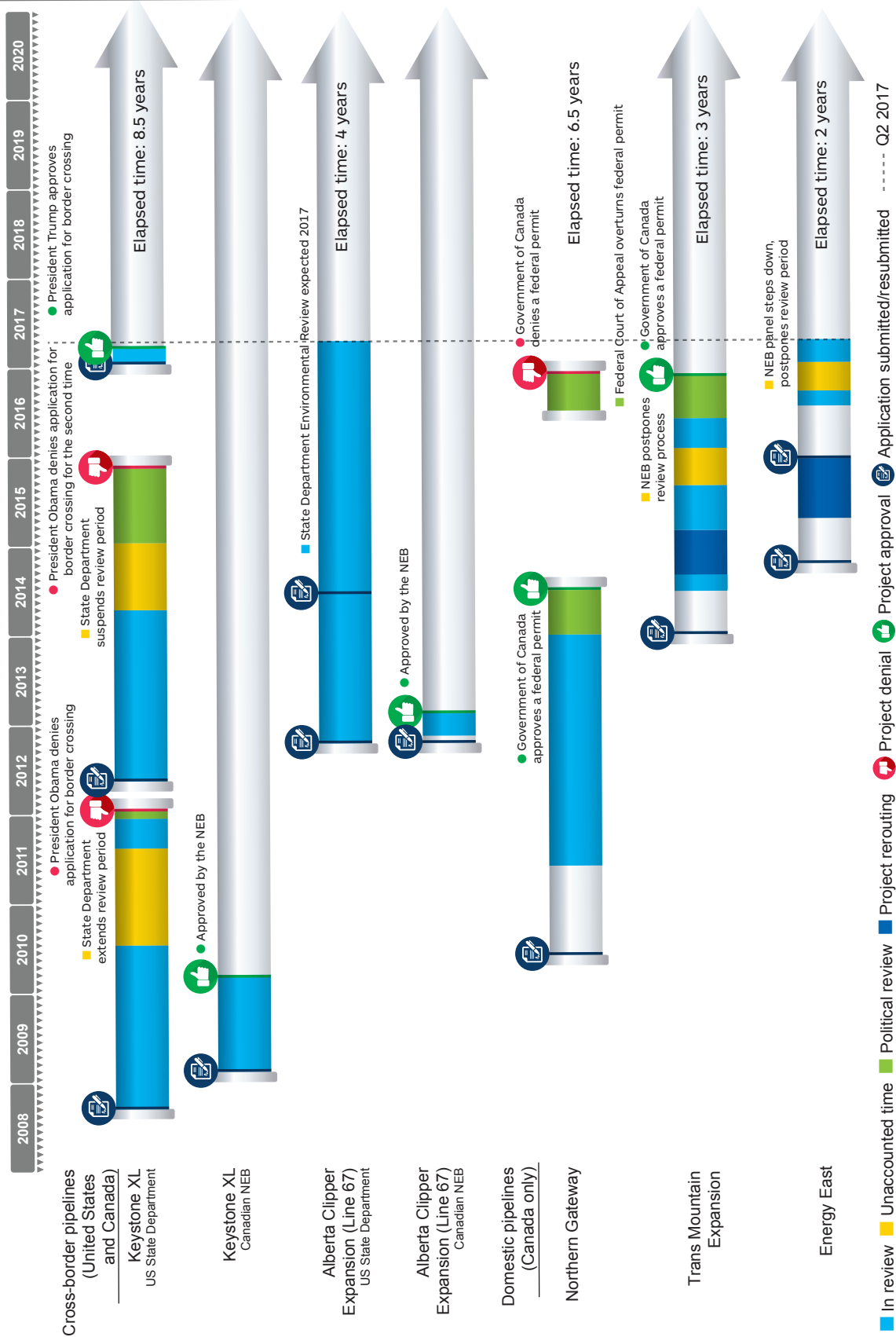
A cautious sense of optimism may be taking hold in western Canada as oil prices gradually recover and as the prospects of new pipelines seem to be tipping in producers' favor. The Trans Mountain Expansion received permits from the

8. See the "National Energy Board Report—Trans Mountain Expansion Project," Appendix 3, retrieved 5 April 2017.

9. The DAPL is a \$3.8 billion, 1,172-mile pipeline that would connect North Dakota tight oil production from the Bakken region to inland US refining markets.

Figure 3

Historical review of the timing of major western Canadian export pipelines proposals



Note: This figure illustrates the timelines of major Canadian export pipelines. Image is not to scale. Numerous sources were used in the making of this figure. There are three pipeline projects that fit wholly within the federal government of Canada review processes and two that would cross international boundaries into the United States and require review by the US State Department and a presidential permit to construct a new border crossing. Additional federal, provincial, and state processes may also be triggered by these projects but were not included for brevity. Time can occur between applications to the Canadian federal review process until the issuance of a hearing order, which marks the commencement of a formal review process. Estimate of total elapsed time is based on time of first application to the beginning of 2017.

Sources: NEB, US Department of State, US Congress, Obama White House Archives, The White House, Nebraska Supreme Court, Prime Minister of Canada, Canadian Federal Court of Appeal

Government of Canada on 29 November 2016, with the Province of British Columbia agreeing not to oppose the pipeline early in 2017.<sup>10</sup> Keystone XL, which was denied a cross-border permit in 2015, received a presidential permit on 24 March 2017 after President Trump invited TransCanada to resubmit an application in early January.<sup>11</sup> The US State Department recently completed a draft of the Supplementary Environmental Impact Statement for the Alberta Clipper (also known as Line 67) Expansion, which will likely advance toward the US president in late 2017 for permission to expand the existing cross-border permit. The Energy East project is the earliest in the process, having reentered the formal hearing process at the NEB in January 2017.

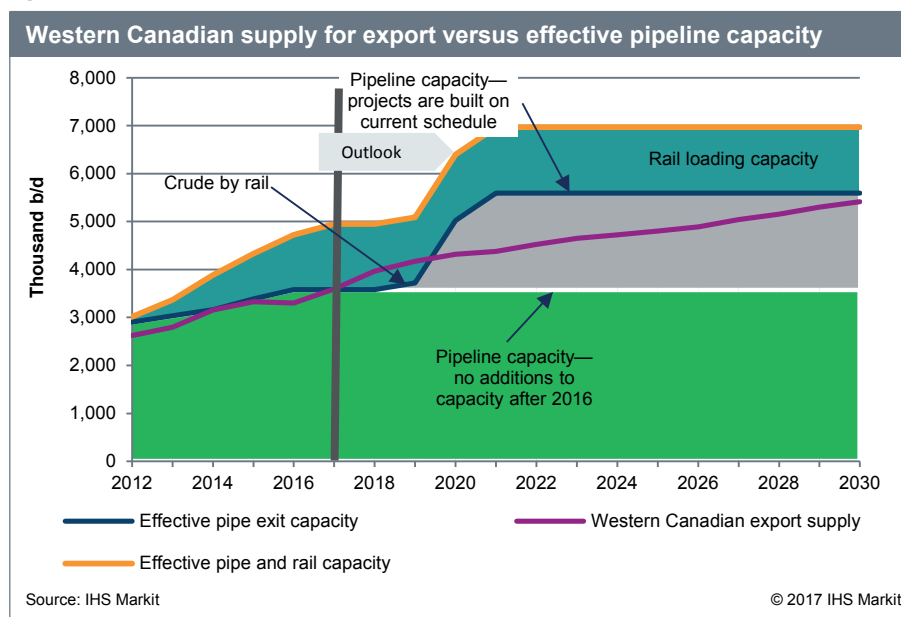
If all four pipeline projects advance as currently proposed, western Canadian pipeline takeaway capacity could move from one of shortage to surplus (see Figure 4). In total, these projects could add nearly 2.9 MMb/d of new pipeline capacity in 2019–22.<sup>12</sup> Pipelines do not operate at 100% of capacity, and not all of this capacity would be exclusive to western Canadian oil producers. Some US production would likely also make use of the south- and eastbound systems. Pipelines also can have different commercial arrangements—some are backed with firm commitments by producers to take or pay for a fixed contracted volume over a specified period, while other pipelines may have spot agreements. However, if completed, these additions could be sufficient to meet growing Canadian supply for some time—removing a cloud of uncertainty that has faced western Canadian producers.

Each pipeline offers producers different benefits. Southbound pipelines would strengthen Canadian-US energy integration and US energy security.

Others heading to the coasts (east or west) would provide Canadian production an opportunity to access global markets and diversify away from dependence on a single market (the United States). Although the United States (the Gulf Coast in particular) remains the most likely market for growing Canadian heavy supply owing to the region's preexisting refinery capacity capable of processing heavier crudes, lessons from the timing of Keystone XL and concerns about a possible resurgence of US protectionism have highlighted the importance of market diversification. In 2016, 99% of Canadian crude oil exports went south to the US market.

For the time being, however, none of these proposed pipelines change the likelihood that a resurgence of crude by rail out of western Canada is expected through the end of the decade. With the earliest of any proposed pipelines potentially online in 2019, western Canadian supply growth seems destined to overtake available capacity, and increasing movements of crude by rail are expected—and with that prices should decline. Although IHS Markit anticipates greater price discounts, they should be more modest than in the past, as years of investments in crude-by-rail infrastructure, such as loading terminals and railcars, are expected to pay off. The timing and scale of the future movements will depend

Figure 4



10. See the Government of Canada's news release "Government of Canada announces pipeline plan that will protect the environment and grow the economy," retrieved 22 March 2017, and the Province of British Columbia's news release "Five conditions secure coastal protection and economic benefits for all British Columbians," retrieved 22 March 2017.

11. On 24 January 2017, President Trump invited TransCanada to reapply, promising an expedited, 60-day review. The application was submitted by TransCanada on 26 January 2017. The US State Department issued its decision on 24 March 2017, with the president indicating that the pipeline would receive a permit. Source: "Presidential Memorandum Regarding Construction of Keystone XL Pipeline," The White House, retrieved 5 April 2017, and "President Trump Delivers on Jobs for American People," The White House, retrieved 5 April 2017.

12. This figure includes Keystone XL, the Trans Mountain Expansion, the Alberta Clipper Expansion, and Energy East.

on the rate of supply additions over the next year, including when conventional supply begins to expand again and the ability of pipeline companies to continue to optimize their systems. It should be noted that even in the event that pipeline capacity expands, some volumes of crude-by-rail are expected to persist as rail can provide additional optionality for producers.

Despite the optimism, there is no guarantee that these projects and other expansions will advance as proposed. These projects remain controversial and may face additional challenges. Within weeks of the federal permit being issued, it was reported that at least eight requests for judicial review had already been filed against the Trans Mountain Expansion—a plan to twin an existing line.<sup>13</sup> Although Keystone XL is now permitted, it will likely face legal challenges and still require state-level approvals, which may yet complicate its completion. President Trump also has previously suggested that new pipelines could be subject to additional conditions; these conditions could affect both the Keystone XL and Alberta Clipper Expansion, which is still seeking its presidential permit. Only time will tell whether the pipelines continue to meet delay or if the necessity of new infrastructure for western Canadian oil producers is realized.

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13. See “[Environmentalists file court challenge of Ottawa’s Trans Mountain pipeline approval](#),” CBC News, retrieved 5 April 2017.

## IHS Markit team

**Kevin Birn**, Senior Director, IHS Markit, is part of the North American Crude Oil Markets team and leads the Oil Sands Dialogue. His expertise includes energy and climate policy, project economics, transportation logistics, and oil market fundamentals. His recent research includes analysis of the greenhouse gas intensity of oil sands, economic benefits of oil sands development, upgrading economics, oil sands competitiveness, and implications of advancing climate policy. To date, Mr. Birn has authored or coauthored 30 reports associated with development of the Canadian oil sands. Prior to joining IHS Markit, Mr. Birn worked for the Government of Canada as the senior oil sands economist at Natural Resources Canada. He has contributed to numerous government and international collaborative research efforts, including the 2011 National Petroleum Council report “Prudent Development of Natural Gas & Oil Resources” for the US secretary of energy. Mr. Birn holds undergraduate and graduate degrees from the University of Alberta.

**Karen Kuang**, Senior Analyst, IHS Markit, is a member of the North American Crude Oil Markets team. Her expertise includes modeling and analysis of crude oil and refined petroleum product supply and demand, price forecasts, and transportation costs. She is the primary modeling resource for the North American Crude Oil Market and Refined Product Market research/consulting team. Ms. Kuang has participated in numerous oil, natural gas, and NGL research and consulting projects. Ms. Kuang holds degrees from China University of Geosciences and an MBA from the University of Calgary.

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