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# LIKELY MARKET RESPONSES TO A SHUTDOWN OF LINE 5

October 2023
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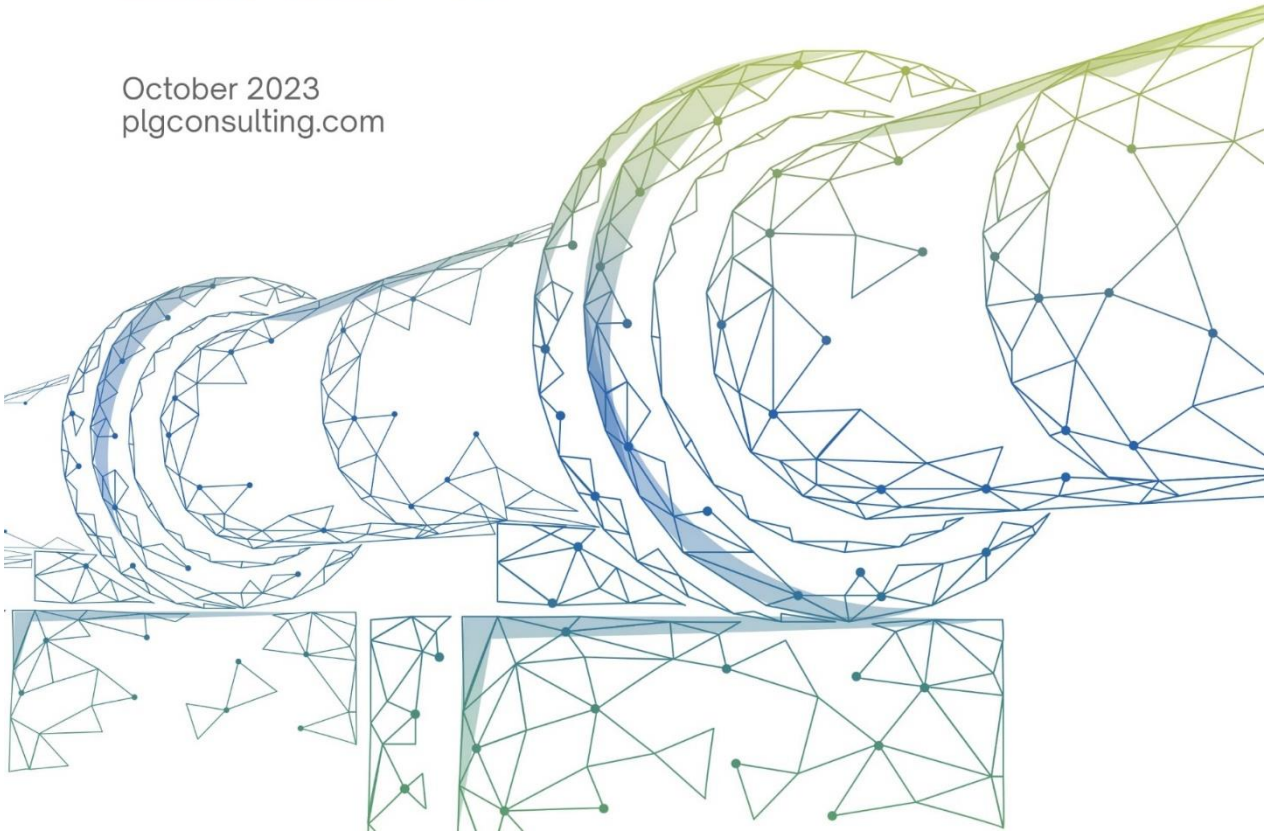

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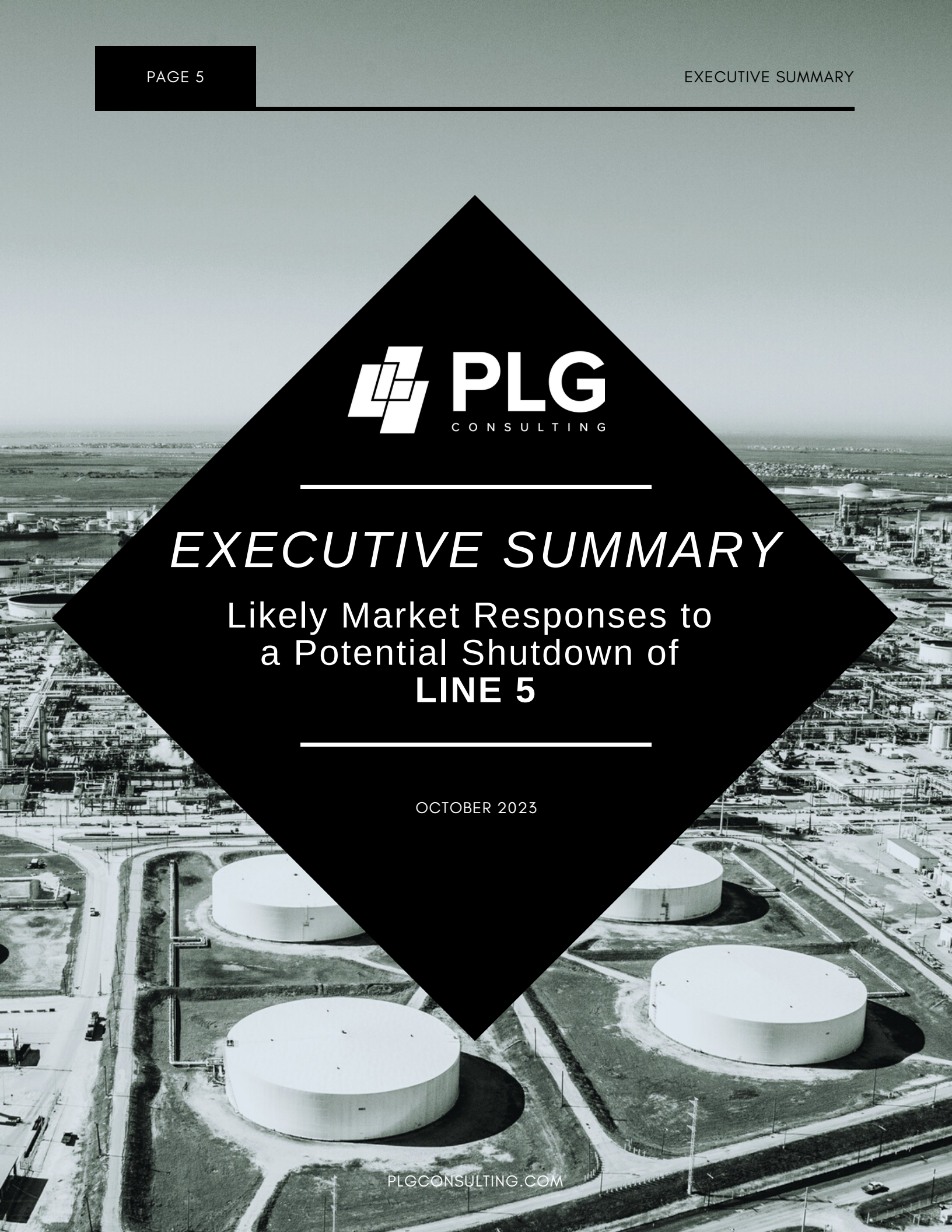

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# *EXECUTIVE SUMMARY*

## Likely Market Responses to a Potential Shutdown of **LINE 5**

OCTOBER 2023

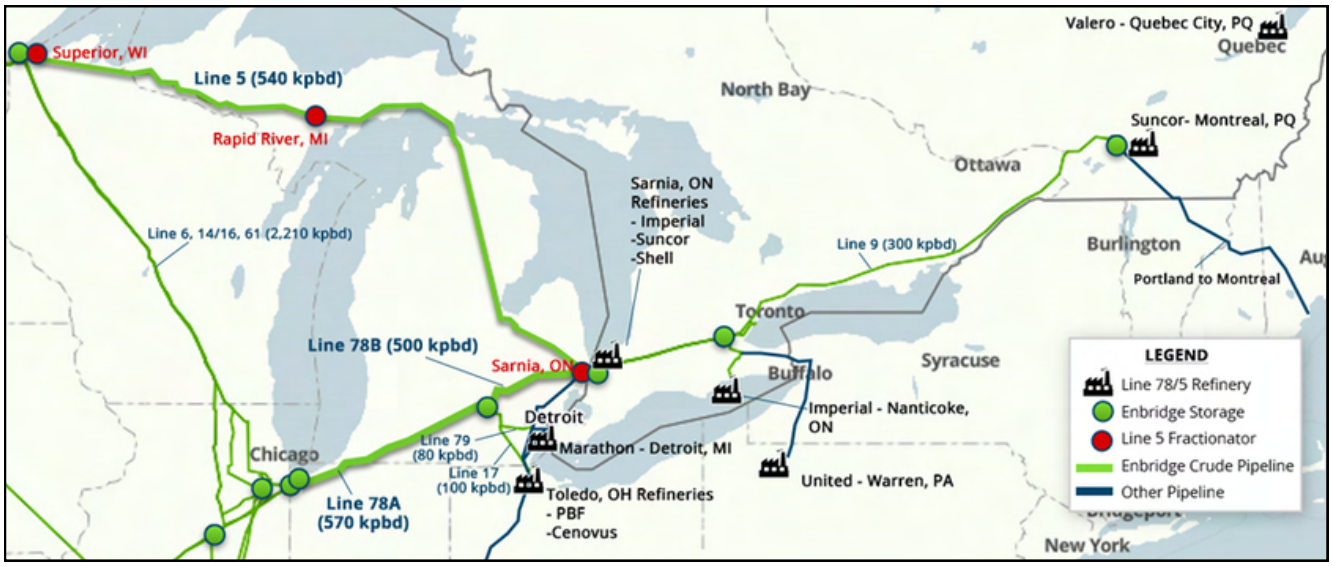
The North American energy markets are dynamic and constantly adapting to change. In this report, PLG examines the suite of potential market adjustments that could be made in the event of a planned and orderly shutdown of Enbridge's Line 5 pipeline. PLG takes no position on the merits of a shutdown, and the purpose of the report is not to prescribe any particular set of market reactions – those will be for the market to determine. Rather, it is PLG's conclusion that for both the crude oil and NGLs currently transported by Line 5, there exists a range of replacement options that are both commercially viable and operationally feasible. This report explores those options in detail.

# ABOUT LINE 5

First constructed 70 years ago, Line 5 is part of Enbridge's Lakehead System, a network of pipelines in the Great Lakes region. It is fed by Enbridge pipelines originating in Western Canada.

## LINE 5 AND ENBRIDGE'S LAKEHEAD SYSTEM*

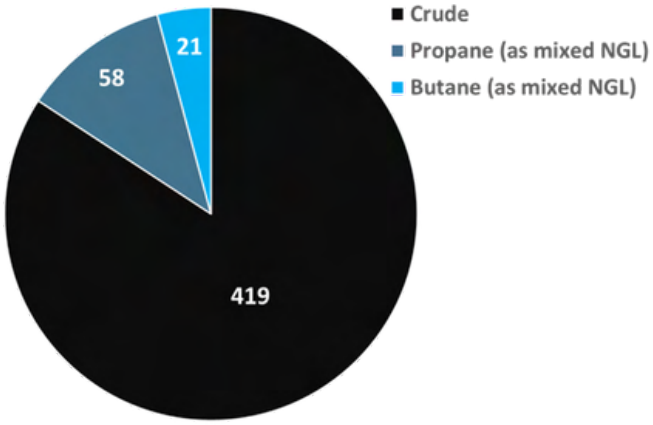
*kbpd = capacity




## PRODUCTS TRANSPORTED BY LINE 5

Line 5 transports crude oil and natural gas liquids east from Superior, Wisconsin, to Sarnia, Ontario. It conveys between 400,000 and 450,000 barrels per day (bpd) of crude oil, in addition to about 80,000 bpd of NGLs.

Total Products Handled by Line 5 (kbpd)



# LINE 5 SAGA

## LINE 5 SAGA EXPLAINED

For the past several years Line 5 has been the subject of litigation and policy efforts seeking to terminate its operation by various plaintiffs and at various locations along the route.

**These disputes and concerns around Line 5 have been ongoing for about ten years and are widely** known within the energy industry and among various service providers and market observers. **However, a material development in the Line 5 saga occurred this past summer when a Federal court ruling issued for the first time a date-certain requirement of June 2026 for the removal of Line 5 from a 13-mile portion of the route in northern Wisconsin.** A shutdown could occur sooner due to an appeal of that decision.

***FOR THE FIRST TIME IN THE LINE 5 SAGA,***

*a Federal court has ordered a date-certain of June 2026 for the removal of part of the pipeline.*

***PLG Consulting offers no opinion regarding the merits of the policy and legal disputes surrounding Line 5.***

However, given recent developments, PLG has undertaken this analysis in an attempt to answer the narrow question of what would happen to Line 5 products and markets in the event of a planned and orderly shutdown of Line 5. In other words, **were Line 5 to shut down - for any reason - how can and would the market adapt in order to continue to deliver critical energy supplies to affected regions and customers, both reliably and cost-effectively?**

# KEY FINDINGS

## ALTERNATE LINE 5 SUPPLY

Based upon careful research as well as PLG's more than 15 years of consulting experience in energy supply chains and logistics, our analysis demonstrates that **energy markets will adapt - as they have always done and continue to do - in the event that Line 5 is shut down.** With advance notice, the markets can be expected to do so without supply shortages or price spikes.

**The companies participating in Line 5 products and markets are sophisticated and large energy firms that regularly evaluate and anticipate risks and market changes.** Therefore, it's not surprising that **for at least the past six years, contingency plans have been developed** by key refiners and other businesses whose supply chains may be altered in the event of a Line 5 shutdown.

This conclusion is based on a multitude of factors relating to both the overall hydrocarbon supply chain in North America and the specific Line 5 products and markets:

| CHARACTERISTICS OF THE NORTH AMERICAN ENERGY INDUSTRY | |
|---|---|
| **Attribute** | **Implication for Line 5 Products and Markets** |
| North America is an integrated energy market | • A multitude of alternative supply sources exist from both domestic and international sources. |
| Robust logistics interconnectivity across multiple modes | • No region of the continent, including the Line 5 market area, is dependent on a single source or mode of supply. |
| Surging output has established full energy independence for the continent | • There is no risk of supply shortages or over-exposure to foreign supply. |
| Supply chains are constantly evolving and adapting | • A reconfiguring of supply to Line 5 markets would not entail any novel approaches; identified alternative solutions are:<br>◦ usual and customary for the industry<br>◦ already in use, supplying Line 5 markets today |

## KEY FINDINGS Cont'd

| RELEVANT RESILIENCY CHARACTERISTICS OF LINE 5 PRODUCTS & MARKETS | |
|---|---|
| **Attribute** | **Key Insights** |
| Line 5 delivery area markets have access to multiple alternative sources of crude, refined products, and NGLs. | • Even today, no refinery relies entirely on Line 5 for its crude supply. |
| The logistics infrastructure, networks, terminals, and routes largely already exist and have sufficient capacity to provide delivery of alternatively-supplied crude and NGLs to the Line 5 market area. | • Nearly all of the identified alternative solutions are already delivering crude and NGLs to the Line 5 region today. |
| The market players already involved with Line 5 products and markets are sophisticated and large companies that regularly evaluate and anticipate risks and market changes. | • Contingency plans by sophisticated market players have been under development since 2017 and can be implemented quickly. |

Taken together, the characteristics of overall North American energy supply chains combined with the unique circumstances of Line 5 products and markets mean there is a range of commercially viable and operationally feasible supply chain alternatives for each of the end use destinations and markets that would be affected by a Line 5 shutdown.

**Commercially viable** means that while total delivered costs of new alternative supply chain solutions may not be the exact same cost as today, any increases in costs would be nominal and would not materially affect the affordability or market competitiveness of product delivered to any given Line 5 destination area.

**Operationally feasible** means that none of the alternative supply or logistics solutions would involve any unusual or novel approaches, equipment, facilities, or technology.

## ALTERNATIVE SOLUTIONS FOR POTENTIAL LINE 5 SHUTDOWN

**Phase I solutions are those that can be implemented almost immediately (i.e., within three months) without major capital investment.** Most of these solutions currently supply the Line 5 area and would only need to increase volume. While all identified Phase I solutions can commence operations almost immediately (i.e., within three months), in some cases, those solutions may need additional months to "ramp up" to achieve full potential volume.

**Phase II solutions are those solutions likely requiring 12-18 months for implementation and/or nominal capital investment before commencing operations.**

*It is important to emphasize that for all products and markets, Phase I and Phase II solutions together are able to satisfactorily provide commercially reasonable and operationally feasible alternative supplies of Line 5 products to affected facilities and areas with 100% of the required replacement volume.*

The report provides an analysis of alternative supply chain solutions for Line 5 products and markets, presented separately for:

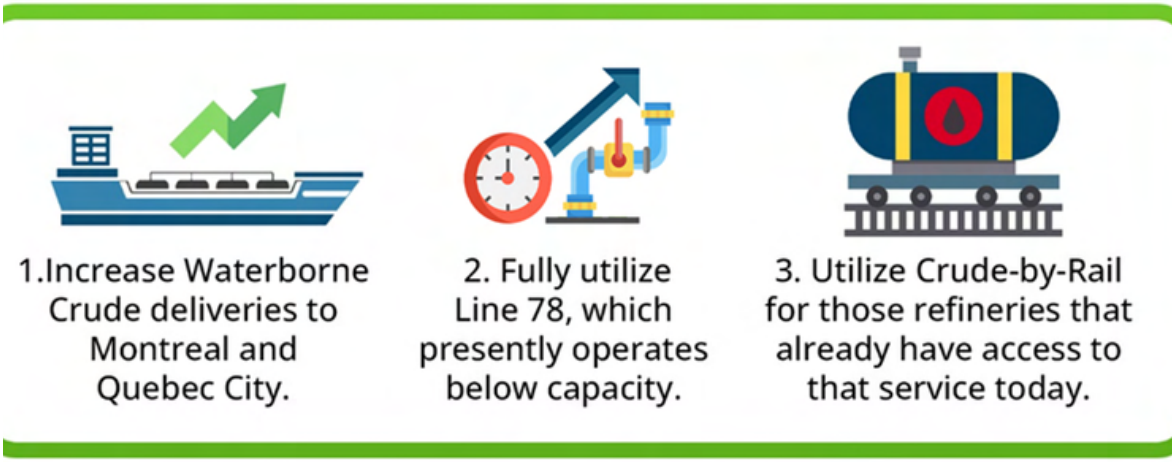
1. Crude oil (and, as appropriate, the downstream delivery of refined products that are derived from the refining of crude oil); and
2. NGLs, specifically the relevant purity products propane and butane.

## CRUDE OIL KEY FINDINGS

Crude oil handled by Line 5 combines with a larger supply of oil from various modes and sources that support ten refineries in Quebec, Ontario, Pennsylvania, Ohio, and Michigan. Line 5's contribution to the crude oil supply for the region makes up only about 1/3 of the total demand of about 1.3MM bpd, which is met by other pipelines as well as other delivery modes.

Phase I Immediate Term (within three months) Alternative Supply Chain Solutions for Crude Oil

**Existing infrastructure can offset all but 53 kbpd, or 13%, of Line 5's supply of crude.**




**1. Increase waterborne crude deliveries to Montreal and Quebec City, which before 2015 was the primary means of crude supply to both refineries.**

**Before 2016, Quebec refineries did not receive any crude oil supplies from the Enbridge System.** Instead, they received almost all of their deliveries from ocean-borne vessels arriving in Atlantic ports.

*Converting Quebec refineries to all-waterborne imports would make up nearly half of a crude shortfall created by a Line 5 shutdown.*

**2. Fully utilize the existing capacity of Line 78, which presently only operates at 78% capacity - representing 128 kbpd of new volume that may be delivered via that route.**

## CRUDE OIL KEY FINDINGS, Cont'd

**3. Utilize existing crude-by-rail offload capacity at refineries or nearby terminals with that capability today.**

**Additional Resiliency in the System**: Delivery of Refined Products to Eastern Canada and Northeast US Markets from Refineries Outside the Line 78/5 Area.

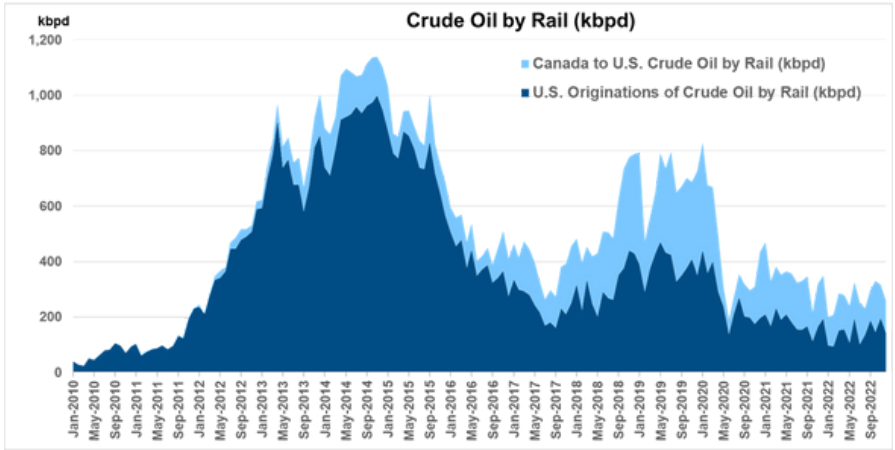
*Refined products delivered from other regions can backstop the loss of refinery output in the Line 78/5 region.*

Phase II Near-Term (within eighteen months) Alternative Supply Chain Solutions for Crude Oil


The amount of investment required to enhance the crude-by-rail services and infrastructure is well below historical investment amounts. Enhanced crude-by-rail capability can be installed at Sarnia or Toledo at a cost range of approximately $15MM-$35MM and completed within 18 months. Within the context of historical volumes, new crude-by-rail demand created as part of alternatives to Line 5 (which are estimated to be between 37-90 kbpd) would be quite small.

*With "take-or-pay" commitments, crude-by-rail terminals typically pay for themselves within less than five years.*

US and Canada Originations of Crude Oil by Rail




*Crude-by-rail activity created by a potential Line 5 shutdown would amount to just 3-8% of historical peak volumes.*

Under the full 18-month Line 5 shutdown scenario whereby Phase I and II solutions are fully enacted, the total weighted average landed cost across all ten Line 5-related refineries and their crude oil supply has an estimated weighted average of **$86.52/bbl**, an increase of **$0.68/bbl**.

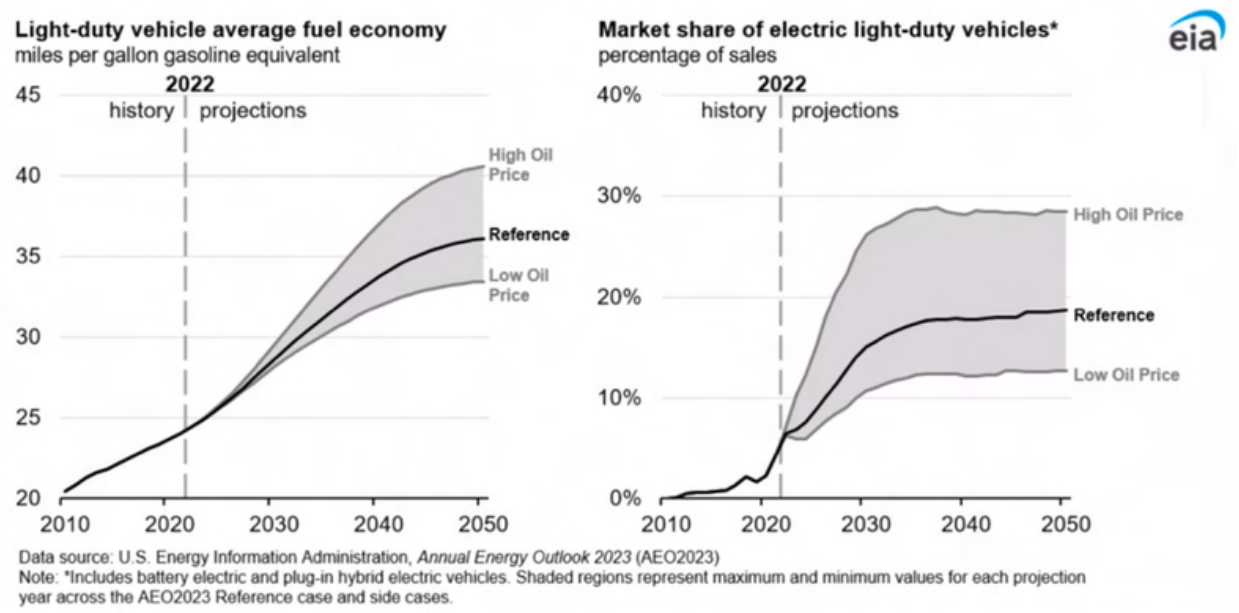
## CRUDE OIL KEY FINDINGS, Cont'd

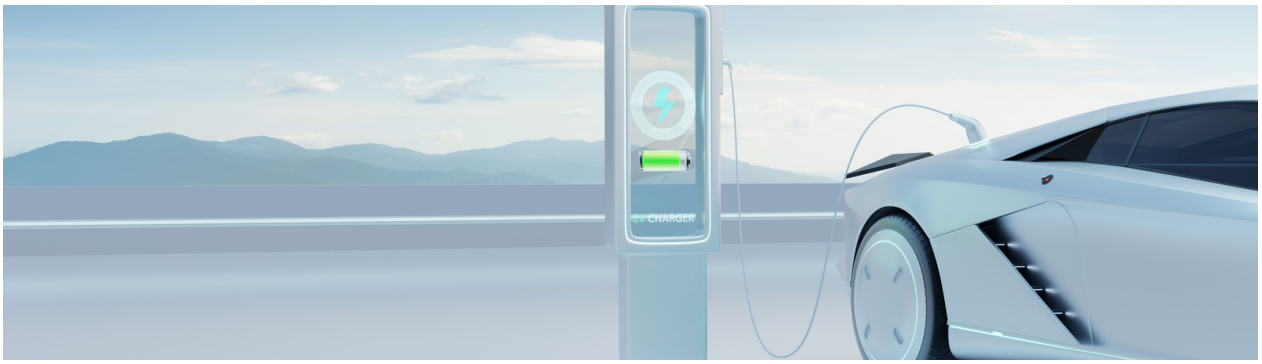
> *While Line 5 replacement crude can be readily supplied, long term trends will diminish demand over time.*

### Long-Term Implications of Decarbonization on Refined Fuels Demand

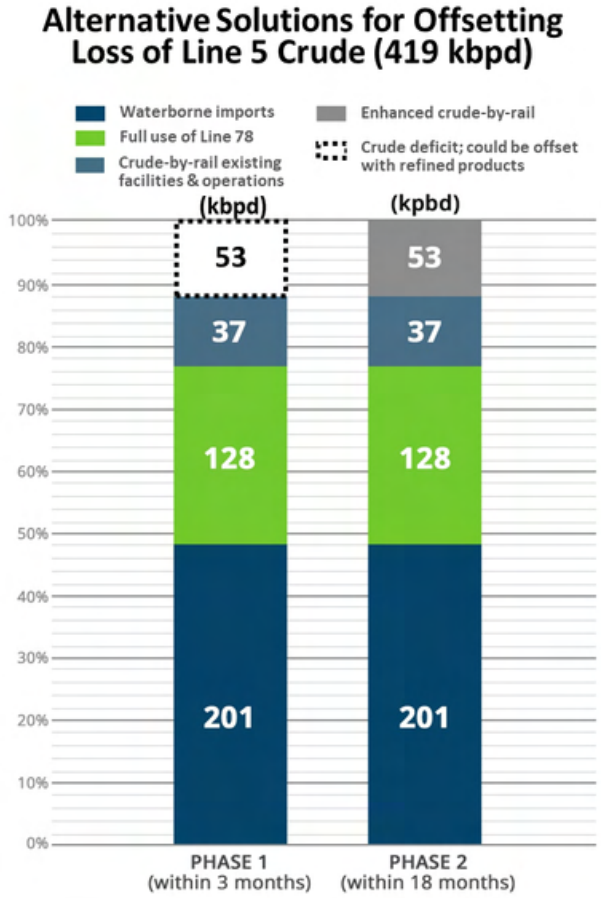
Other long-term trends, alongside Canada's recently enacted Clean Fuel Regulations, are working to diminish the overall use of refined fuels made from traditional hydrocarbons. Not only have vehicle fuel efficiency standards reduced gasoline demand, but the rapidly growing market share for electric vehicles provides an additional macroeconomic factor that will cause the US and Canada to continue reducing the use of refined fuels derived from fossil fuels.

Light Duty Vehicle Economy Trends & Market Share of EVs



## Summary of Alternative Phase I and Phase II Supply Chain Solutions for Crude Oil

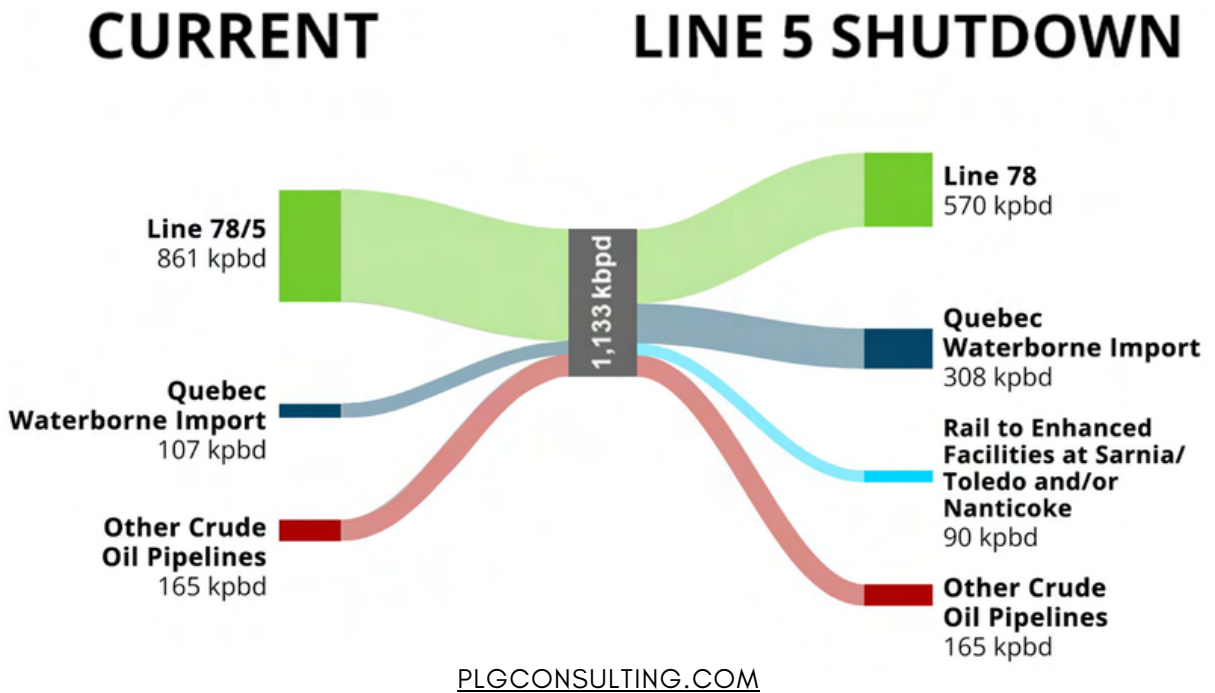



**Key highlights:**

- About 87% of crude supply replenishment is achieved under Phase I because those solutions rely on sourcing and logistics already employed by area refineries.
- Crude supply shortfalls that might occur during Phase I may be offset in part by the availability of refined products from other regions, which would only add about one-half to one cent per gallon of gasoline.
- Following the implementation of Phase II solutions, refineries could replace 100% of their crude oil supply with an increase in the average weighted cost per barrel of just $0.68/bbl.

## Current vs. Future Crude Oil Supply Chain for Line 5-Related Refineries in the Event of a Line 5 Shutdown and Following Phase II Implementation

*The resulting reconfiguration of the comprehensive regional crude supply picture following the implementation of Phase II alternative supply chain solutions can be visualized here.*

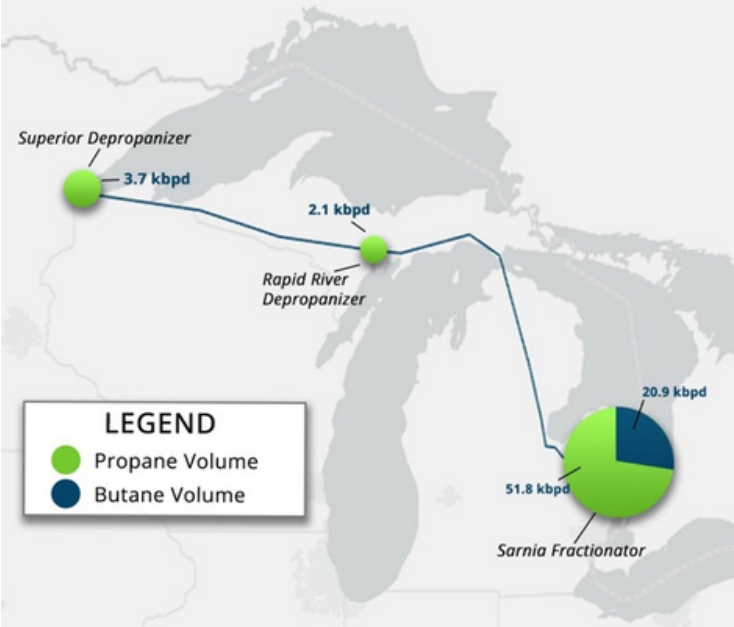


## NGL KEY FINDINGS

**Line 5 services two distinct NGL markets** that must be analyzed separately. For propane in particular, the analysis of Phase I, II, and III alternative solutions must be separated by the two distinct markets that Line 5 services:

1. **The residential propane distribution to northern Wisconsin and the Upper Peninsula and northern Lower Peninsula of Michigan**, and
2. the **combined industrial and residential distribution that occurs from the storage caverns within the greater Sarnia/Port Huron area where propane is stored in preparation for the wintertime peak heating season.**

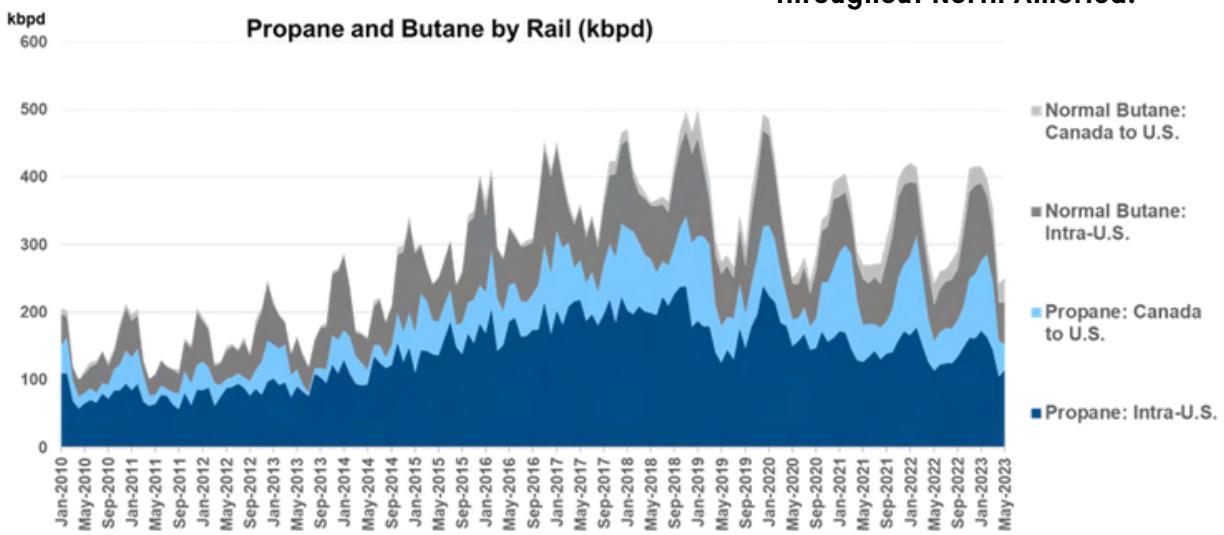
Line 5 Fractionators with Propane and Butane Throughput




**Key highlights:**

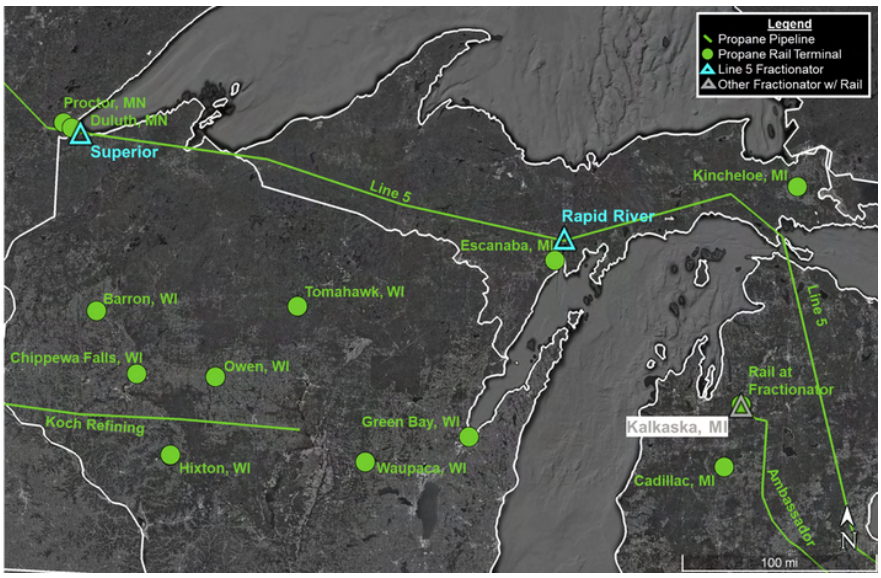
- The NGLs mix that travels on Line 5 is almost exclusively composed of propane and butane and is estimated to be in the proportion of 57.6 and 20.9 kbpd, respectively (70.2% and 25.5%).

- In analyzing the various options for the replacement supply of NGLs to the Line 5 market areas in the event of a Line 5 shutdown, it is important to underscore several key points:
  - **The replacement volumes of NGLs do not need to come exclusively from Western Canada.**
  - **The ultimate goal is to deliver purity products.**
  - **Rail is and will continue to be a primary means for delivery of NGLs to the Line 5 market area end users and throughout North America.**



## ALTERNATIVE SUPPLY CHAIN SOLUTIONS FOR PROPANE DELIVERY TO WISCONSIN, THE UPPER PENINSULA, AND NORTHERN MICHIGAN

### Phase I Immediate Term (within three months) Solutions




The Phase I solutions that are available for implementation immediately are:

1.**Fully utilize existing rail terminal facilities**, and

2.**Fully utilize the Ambassador distribution hub at Kalkaska, MI**.

If existing facilities cannot replace all Line 5 propane in this region, portable transloaders could help offset the remaining propane deficit until Phase II solution(s) are implemented.

### Phase II Near-Term (within 18 months) Solutions

1. **Expand existing or build one or more additional rail terminals** in the region.

> *At least six candidate location options have been identified for additional propane rail terminal(s) in the Upper Peninsula.*

Representative Example of Propane Rail Terminal

Source: TransTech Energy, Truck and Rail Terminals (Retrieved October 2023)

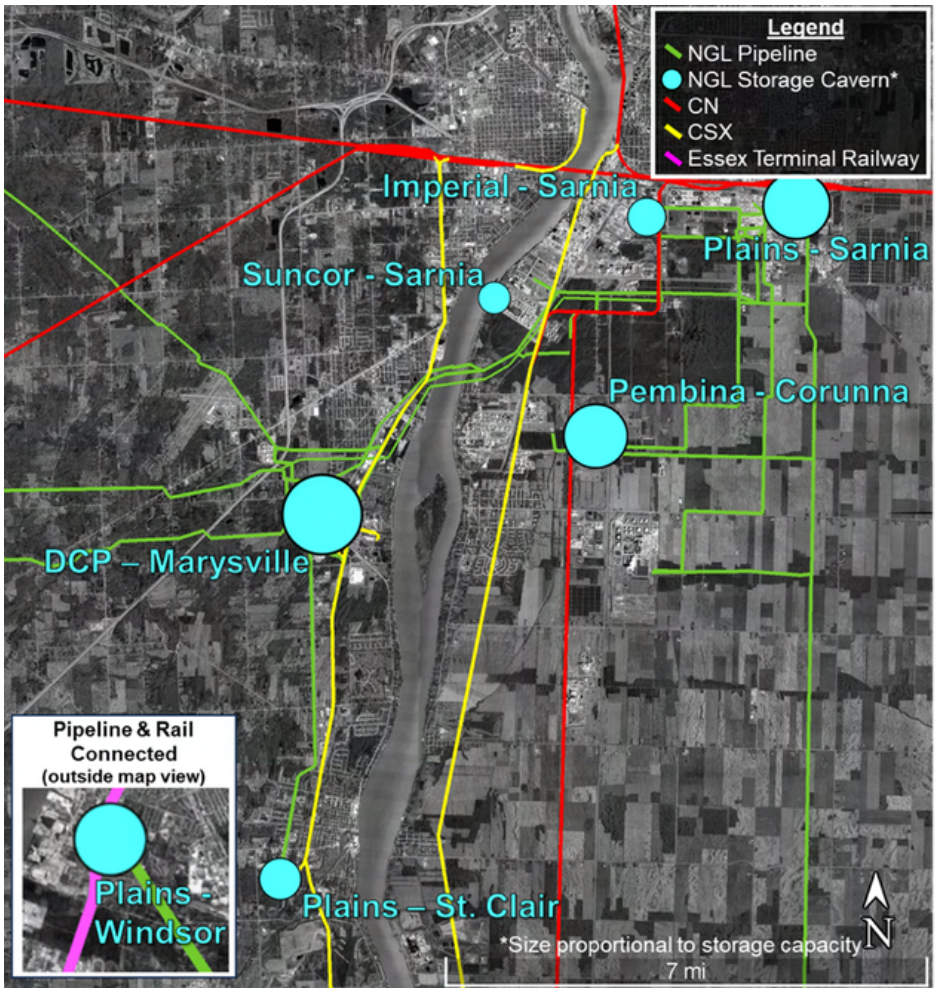
## ALTERNATIVE SUPPLY CHAIN SOLUTIONS FOR PROPANE DELIVERY TO SARNIA AREA STORAGE CAVERNS AND DIRECT-SHIPMENT TO CUSTOMERS

In evaluating alternative solutions that are available for delivery of propane and butane to the Sarnia and eastern Michigan areas in the event of a Line 5 shutdown, there are several factors to consider:

- Plains-Sarnia is just one of five large-scale non-refinery storage caverns in the Sarnia/Port Huron/Windsor area.
- Even if Line 5 were to shut down and the Plains-Sarnia fractionator was to close or reduce operations as a result, the storage facilities could continue to operate.

### Phase I Immediate Term (within three months) Solutions

Sarnia/Port Huron/Windsor Area
NGL Storage Caverns, Pipelines & Railroads




1. **Delivery of propane via rail to all five of the Sarnia/Port Huron/Windsor area storage caverns**, mainly during summer.

2. **Direct-shipment of purity product from NGLs production areas to Line 5 propane markets**, particularly during peak demand season. Direct-shipment origins can include western Canada, the Marcellus/Utica shale play, the terminal and storage caverns at Marcus Hook, PA, and Morris, IL.

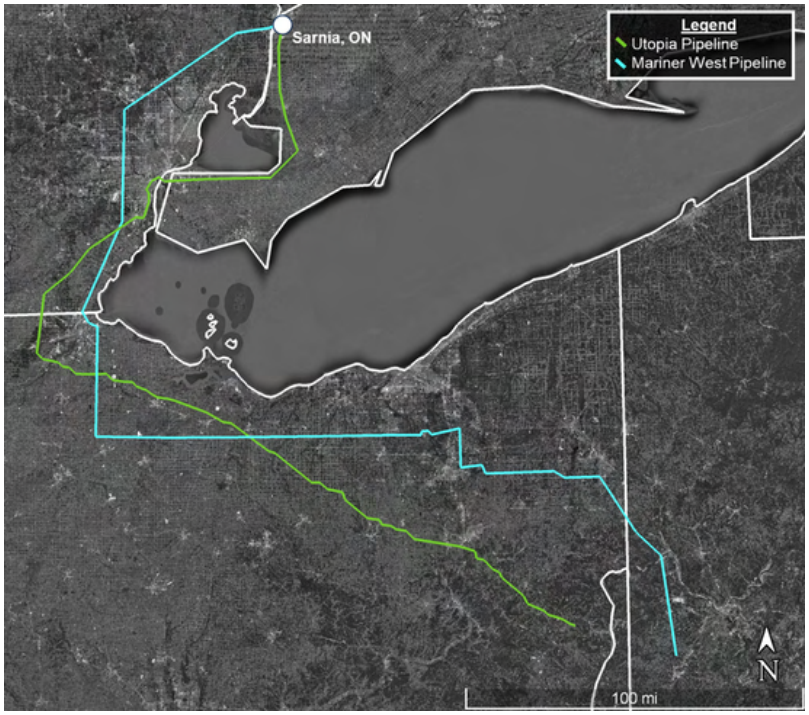
*All of the major NGL storage facilities in the Sarnia/Port Huron/Windsor area are served by rail.*

## NGL KEY FINDINGS, Cont'd

Phase II Near-Term (within 18 months) Solutions

- The solution is to **ship purity propane or a mixed NGL with propane via already existing NGL pipelines currently in ethane service connecting the Marcellus/Utica shale play to the Sarnia/Port Huron/Windsor storage caverns.**

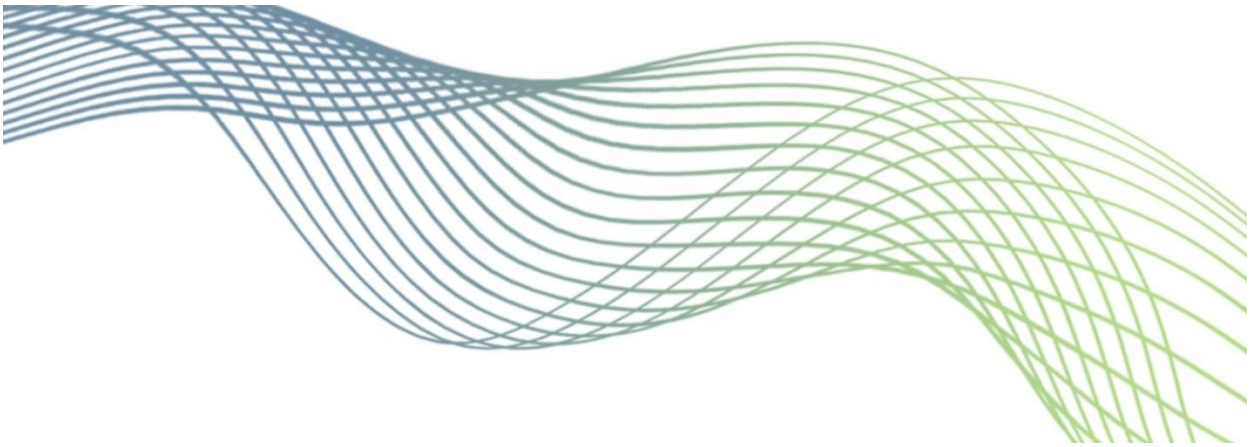
NGL Pipelines from Marcellus/Utica to Sarnia




*Two NGL pipelines already connect the Marcellus/Utica shale play with Sarnia today.*

## SUMMARY

Taken together, it is clear that there exists a range of commercially feasible and operationally viable solutions that can provide alternative crude and NGL supply chains to affected markets in the event of a Line 5 shutdown. That such myriad options exist and can be readily implemented is consistent with the nature of hydrocarbon supply chains in North America, of which Line 5 products and markets are a part.



# I. INTRODUCTION

For the past several years Enbridge's Line 5 pipeline, which handles both crude oil and NGLs between Superior, WI and Sarnia, ON, has been the subject of litigation and policy efforts seeking to terminate its operation by various plaintiffs and at various locations along the route. These disputes and concerns around Line 5 have been ongoing since at least 2017 and are widely known within the energy industry and among various service providers and market observers. A material development in the Line 5 saga occurred this past summer when a Federal court ruling issued for the first time a date-certain requirement of June 2026 for the removal of Line 5 from a 13-mile portion of the route in northern Wisconsin. That decision is presently under appeal.

For the first time in the Line 5 saga, a Federal court has ordered a date-certain of June 2026 for removal of part of the pipeline.

*PLG offers no opinion regarding the merits or particulars of the policy and legal disputes surrounding Line 5*. However, given recent developments, PLG has undertaken this analysis in an attempt to answer the narrow question of what would happen to Line 5 products and markets in the event of a shut-down of Line 5. In other words, were Line 5 to shut down – for any reason – **how can and would the market adapt in order to continue to deliver critical energy supplies to affected regions and customers, both reliably and cost-efficiently?**

For reasons detailed in this report, PLG's analysis shows that energy markets will adapt – as they have always done and continue to do – in the event that Line 5 is shut down. This is not to say that there would not be challenges or issues, because numerous supply and demand areas presently rely on line 5. But what makes such a transition manageable is the nature of hydrocarbon supply chains in North America and the particular characteristics and circumstances of Line 5 products and markets, including:

With advance notice, Line 5 markets can be expected to adapt without supply shortages or price spikes.

- **North America's hydrocarbon supply chains are inherently flexible and adaptable**, combining multiple sources of supply with robust interconnectivity of logistics and transport routes; and

- In the case of Line 5 products and markets, there are **already existing alternative supply chain solutions** that in a matter of months, can provide commercially reasonable and operationally viable deliveries to the affected markets.

## Understanding Hydrocarbons in North America

The term "hydrocarbons" refers to the liquid and gaseous substances (i.e. petroleum and natural gas) that are the result of decaying plants, animals, and fossils underground which for more than 175[1] years have been produced, refined, processed, and consumed as fuels around the world.

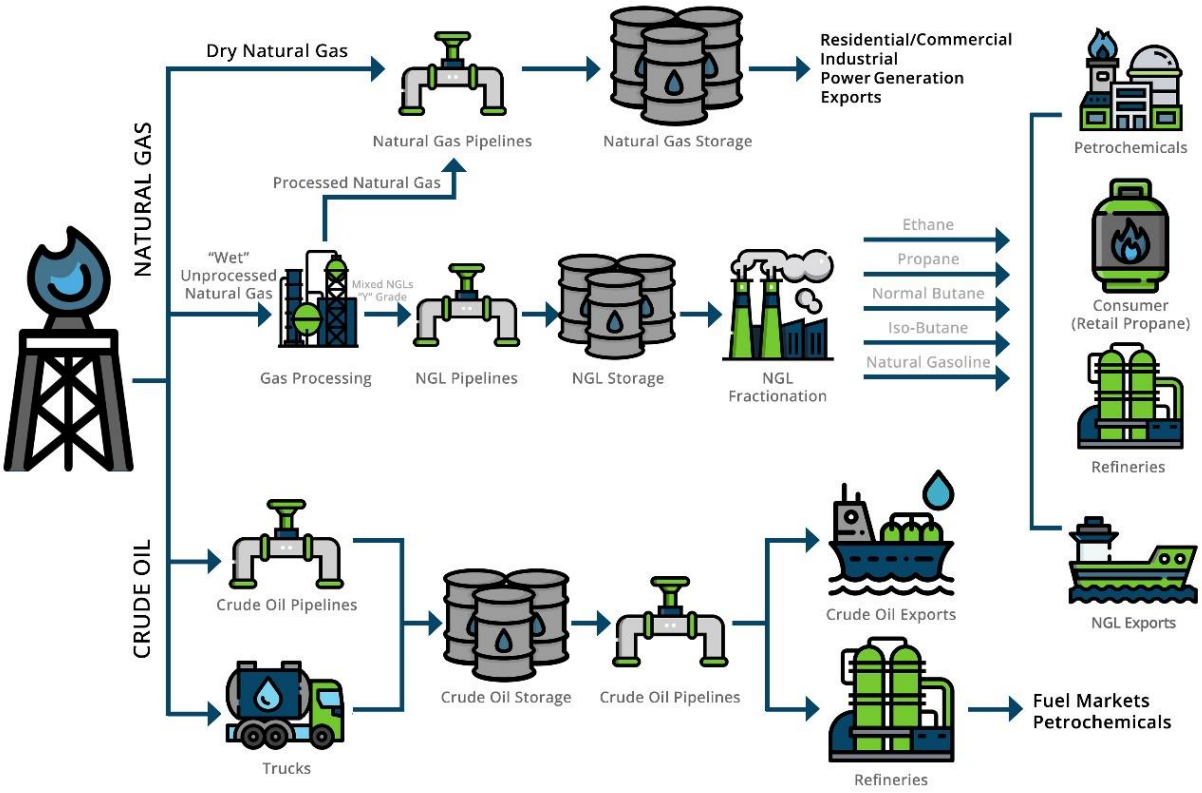
Drilling for hydrocarbons produces three primary commodities, which will vary in proportion and volume depending on the type of hydrocarbons produced:

1. **Crude oil,** which is processed at refineries into petroleum refined products such as gasoline, diesel, jet fuel, asphalt, heating oil, marine bunker fuel, and other products used for their energy or chemical content
2. **Dry natural gas**, which is primarily methane, and is used for a wide range of purposes from heating homes, to generating electricity, to serving as a feedstock for industrial processes
3. **Natural gas liquids (NGLs)**[2], which when initially produced from underground are entrained in the oil or gas production and have to be removed into what is commonly referred to "Y grade" that must be then separated (or, in industry parlance, "fractionated") into their more commonly known purity products, the majority of which are:
    a. Ethane, which is used primarily as a chemical feedstock
    b. Propane, which is used as a chemical feedstock, for home heating, and agricultural and for industrial processes
    c. Butane (including isobutane), which is used as a chemical feedstock and as a gasoline additive at refineries
    d. Natural gasoline, which is used as a gasoline additive or as a diluent

[1] The first well drilled for hydrocarbons was the Drake Well in 1859 at Titusville, PA (Drake Well Museum and Park, *Site History* (Retrieved September 2023))

[2] NGLs are also sometimes referred to as hydrocarbon gas liquids (HGLs)

**Figure 1: Oil and Gas Value Chain**[3]




## North America is an integrated energy market.

It is important to emphasize that North America is an **integrated energy market** in which hydrocarbon production, processing activities, and consumption of the various end use products move freely across the borders of Canada, the US, and Mexico and in various combinations. For example,

- The majority of Canadian crude produced in Alberta is refined in the US Midwest and Gulf Coast
- The US is a primary supplier of refined petroleum products, propane, and natural gas to Mexico
- Canadian energy companies are owners and operators of U.S. natural gas and crude oil pipelines
- Canadian companies are owners and operators of crude terminals in the U.S. including export terminals in the U.S. Gulf Coast
- The US exports crude oil from the Gulf Coast to refineries in Quebec.

[3] RBN Energy, PLG (September 2023)

**Figure 2: U.S. and Canada Major Crude Oil Production Areas, Refineries, and Crude Oil Pipelines [4]**

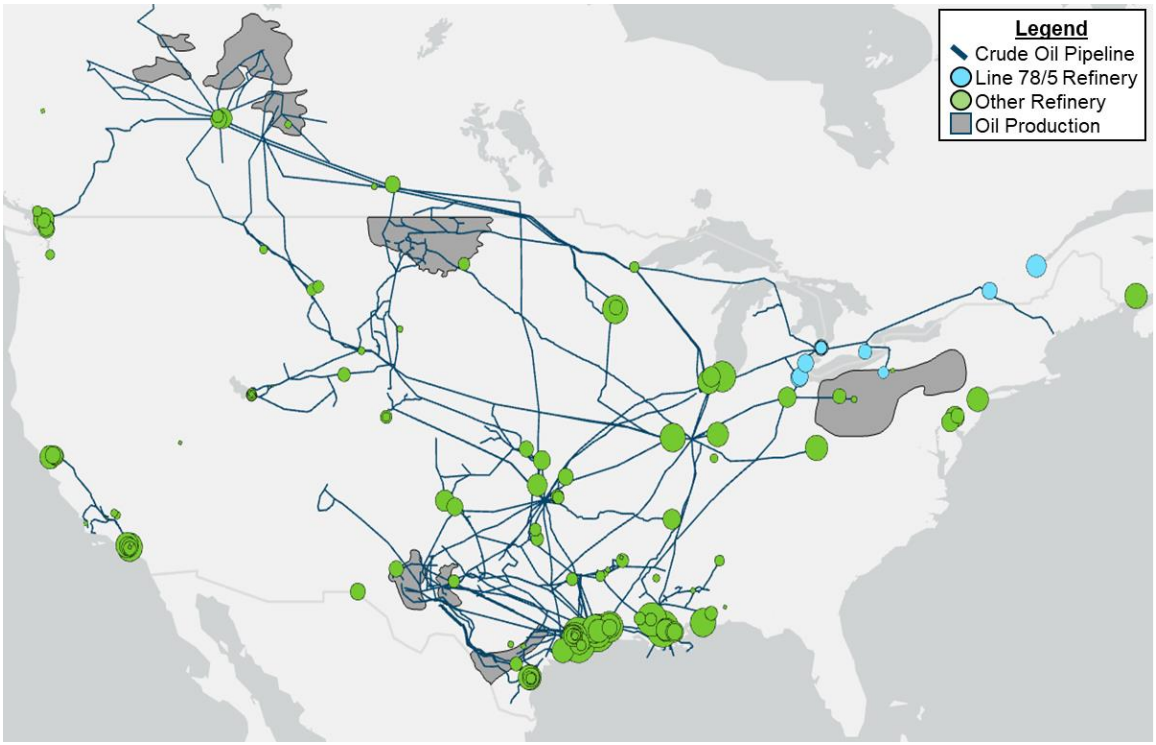
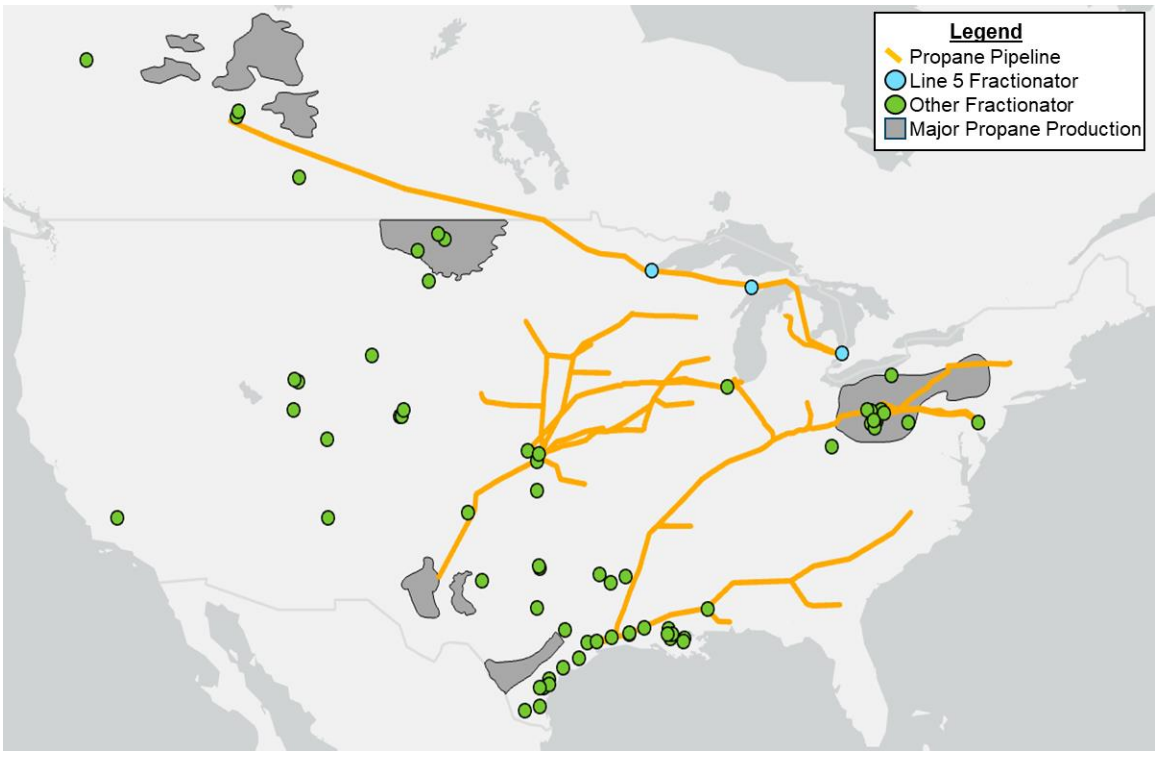



**Figure 3: U.S. and Canada Major Propane Production Areas, Fractionators, and Propane Pipelines[5]**




[4] EIA, CAPP, PLG Analysis (September 2023)

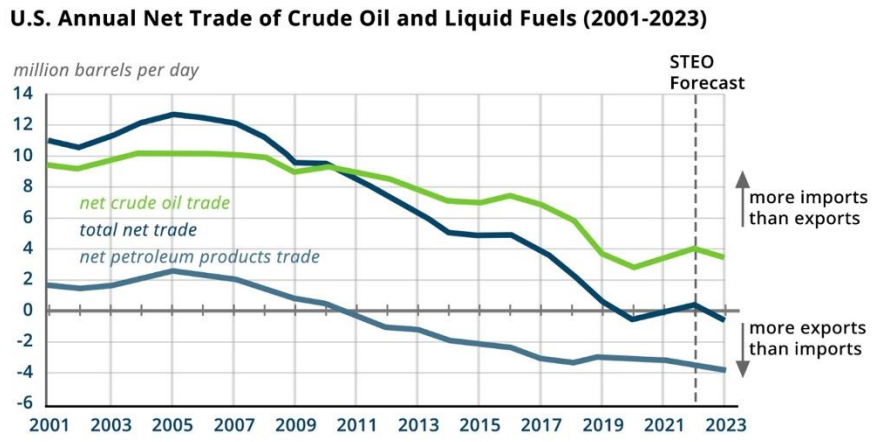
[5] EIA, Canada Energy Regulator, RBN Energy, PLG Analysis (September 2023)

Since 2010 North America has seen surging production levels in all three types of hydrocarbons (crude oil, gas, NGLs) due to new extraction technologies that have allowed for the development of US shale plays and Western Canada "oil sands" region. Those technologies – hydraulic fracturing combined with horizontal drilling for shale resources, and a technique called steam-assisted gravity discharge for oil sands – have produced crude and NGL supplies far exceeding what can be consumed in North America and enabled the export of up to 10% of US natural gas production as liquified natural gas shipments throughout the world. As a result, **the continent is now an export powerhouse for natural gas, crude oil, and NGLs, and North America has been fully "energy independent" for several years.** To illustrate:

Surging production has achieved energy independence for North America.

- The US is now the top oil producer in the world and exports approximately 4MM barrels per day of crude oil[6]
- The US is now a top three supplier of liquified natural gas (LNG) in the world and at times has been the largest[7]
- The US now exports over 1.5 times more propane than is consumed domestically[8]
- Canada now exports more than it consumes for petroleum and other liquids production[9]

**Figure 4: U.S. Annual Net Trade of Crude Oil and Liquid Fuels[10]**




While periodic geopolitical events such as the war in Ukraine may at times affect the price of crude and refined products in the US as they did during the summer of 2022, **the energy independence achieved over the last decade plus has virtually eliminated the risk of inadequate supplies of hydrocarbon energy products in North America.**

## Understanding Energy Supply Chains

The term "supply chain" is a holistic term that encompasses the production of a commodity or good; any required processing, preparation, or storage; transportation and logistics; and end-user delivery inclusive of all costs.

[6] EIA, *U.S. Exports of Crude Oil and Petroleum Products* (August 2023)
[7] EIA, *Global liquified natural gas trade volumes set a new record in 2022* (July 2023)
[8] EIA, *Supply and Disposition of Crude Oil and Petroleum Products* (August 2023)
[9] EIA, *Country Analysis Executive Summary: Canada* (July 2022)
[10] EIA, *EIA expects U.S. petroleum trade to shift toward net imports during 2022* (February 2022)

## Virtually no region of North America is entirely dependent on single sources of supply or logistics for energy products.

The energy supply chains in North America are characterized by flexibility and overlapping optionality in the following ways:

- Multiple plays and production areas for each of the three major hydrocarbon types (crude oil, natural gas, NGLs)
- General fungibility of hydrocarbon products[11]
- Robust reach and interconnectivity of pipeline, marine, rail, terminal, and truck networks handling hydrocarbon products.

The combination of these characteristics creates a matrix of supply chain options. In fact, **virtually no region of the continent is entirely dependent on single sources of supply for crude or refined petroleum products, dry natural gas, or NGLs.**

### Crude Oil Supply Chain

Major crude oil production areas in North America include the Permian Basin in Texas and New Mexico, the Eagle Ford shale play in Texas, the Bakken shale in North Dakota, Alaska North Slope, offshore production in the Gulf of Mexico, and the oil sands region in Western Canada. At present, the Permian Basin is the largest oil production area on the continent, with output nearing 6MM barrels per day[12].

Crude oil is transported primarily by pipeline to the major refining areas, but marine transport has been and continues to be an important mode of delivery. Significant use of crude-by-rail occurred starting around 2011 as the Bakken shale formation was first being developed and production outpaced the construction of pipeline takeaway capacity. A similar phenomenon occurred in Western Canada, as production in that region has at times exceeded pipeline capacity and led to significant use of crude-by-rail. All three modes (pipeline, marine, rail) play an essential role in the transport of crude oil to refineries.

A refinery is an installation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and oxygenates[13]. The US alone has more than 120 facilities for

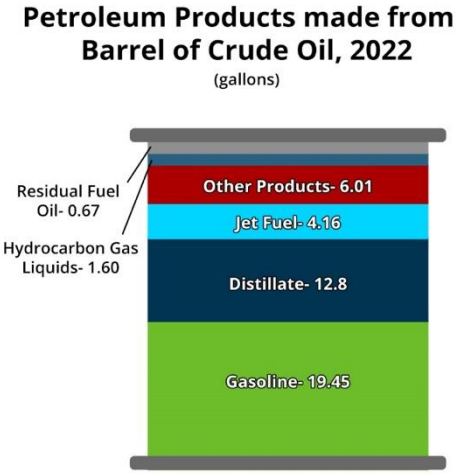
[11] Natural gas is generally fungible, as are NGLs, meaning they are equivalent regardless of production source. For crude oil, there is general fungibility in the "light/sweet" and "heavy/sour" grade categories. "Light/heavy" refers to specific gravity as measured by American Petroleum Institute standards; "sweet/sour" refers to sulfur content. In general, light/sweet grades are well suited for the production of gasoline, while heavy/sour grades are well suited for the production of diesel, jet fuel, and asphalt. This fungibility extends further down the refinery supply chain into gasoline, jet, diesel, heating oil, lubricants, and other refined products. Similar to grades of crude oil, NGL purity products are largely fungible. For example, propane from Alberta, the Marcellus-Utica shales in Ohio, West Virginia and Pennsylvania, and the Eagle Ford shale play in Texas are interchangeable and of equal value and benefit for end users.

[12] EIA, *Drilling Productivity Report* (September 2023)

[13] EIA, *Glossary* (September 2023)

refining of crude oil.[14] Refineries transform crude oil into various refined products including gasoline, diesel, jet fuel, and other products and in varying proportions depending on the grade(s) of crude being processed.

**Figure 5: Petroleum Products Made From a Barrel of Crude Oil**[15]




Once refined petroleum products are made, a separate supply chain is utilized to deliver those products to end use customers. In some cases the distance traveled to market from refiner to consumer can be quite localized, and in other cases the distance can be significant. For example, the refining capacity located on the US Gulf Coast vastly exceeds what local markets can consume. For this reason, large volumes of refined products are sent from the US Gulf Coast via pipeline to southeastern and Atlantic seaboard states. Also, a large share of US Gulf Coast refined products production is exported to Mexico and other destinations overseas.[16]

As an example of the robust logistics infrastructure for refined products, the upper Midwest/Great Lakes area that is germane to this report has extensive terminal, pipeline, and refining infrastructure for the delivery of refined products to end markets. This capability for refined products distribution is explored in further detail later in this report.

### NGL Supply Chain

When "wet" natural gas is produced from the ground, it comes mixed with a variety of hydrocarbons besides methane, the primary component of natural gas. These other hydrocarbons include ethane, propane, butane, isobutane, and natural gasoline (pentanes plus). Before the methane can be sold to homes and businesses, the gas needs to be processed to remove these other hydrocarbons. Two streams result from this processing:

- Pipeline-quality dry natural gas, which is primarily methane and is delivered to consumers for heating, cooking, and electricity generation.

- A mixed NGL stream, often referred to as "Y-grade," which is a mix of the other hydrocarbons.

The Y-grade NGL stream is sent to fractionation towers, where a combination of pressure and heat (temperature) are used to separate out the individual NGL components since each has a different boiling point. This is a process similar to distillation in a crude oil refinery. As such, in the same way that the

[14] EIA, *Refinery Capacity Report* (June 2023)

[15] EIA, *Oil and petroleum products explained* (June 2023); Note: a 42-gallon barrel of crude oil yields about 45 gallons of petroleum products because of refining processing gains. Distillate is a general classification for one of the petroleum fractions that includes diesel fuels and fuel oils.

[16] PADD 3 exported 1,103 kbpd of petroleum products to Mexico in 2022; PADD 3 had refinery net production of 6,379 kbpd in 2022 (EIA, *Exports of Crude Oil and Petroleum Products* and *Refinery Net Production* (August 2023))

process of converting crude oil to gasoline involves two phases of a supply chain – the first being the movement of crude from production area to refinery, and the second being the movement of refined petroleum products to consumers – the NGL stream also has two distinct supply chain phases. The gas stream is delivered by pipeline to a processing plant to remove the Y-grade from the methane, after which the methane is sent via pipelines to market while the Y-grade is transported to a fractionator for separation into purity ethane, propane, butane, iso butane and pentanes plus. Then, the second phase of the supply chain provides for the shipment of those purity products to end use customers and storage activity.

Primary NGL production in North America comes from wet gas streams produced from the Marcellus and Utica shale plays in Ohio, West Virginia and Pennsylvania; the Eagle Ford shale play in Texas; the Permian shale play in Texas and New Mexico; and Alberta. Also, most crude oil production areas have "associated" gas production that occurs with the extraction of crude oil, making each of those areas also important to the supply of NGLs.

Y-grade is fractionated at more than 90 fractionators in the US and Canada. The purity propane, butane and pentanes plus produced are moved via pipeline, rail, truck, and barge to various regions throughout the continent and world. Due to its physical properties, ethane, the largest volume NGL produced, is shipped either via pipeline to plants for use as a chemical feedstock[17] or for export at terminals on the east and US Gulf Coasts.

Propane has three primary end use markets, which necessitates more varied logistics:

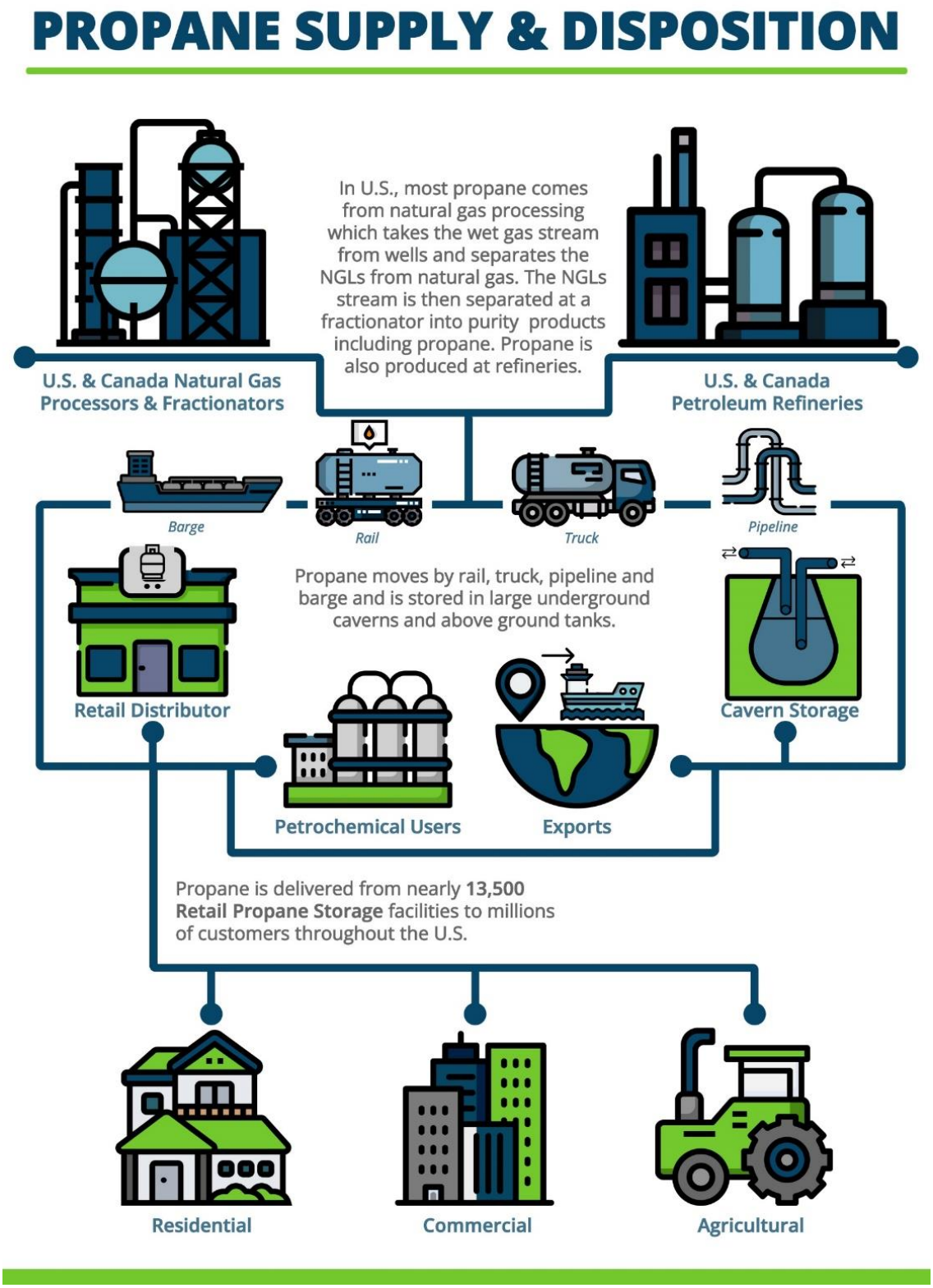
- As a chemical feedstock, which involves pipeline, rail, and truck delivery to chemical manufacturing facilities

- As a power and heating supply for agricultural purposes, including crop drying and heating for livestock barns. Delivery for this purpose takes place via pipeline, rail, and truck, often from major fractionation, storage, and distribution hubs including Mont Belvieu, TX, Edmonton, AB, Conway, KS, Morris, IL, Marcus Hook, PA and Sarnia, ON.

- As a retail fuel for home heating, cooking and to power appliances in rural areas, supplied to hundreds of distribution points throughout the country as "LP gas" via rail and truck, with "final mile" delivery in short trucks called "bobtails."

[17] Ethane is primarily used to make ethylene glycol (antifreeze) or to produce ethylene, a building block for plastics and other chemicals.

**Figure 6: Propane Supply & Disposition**[18]

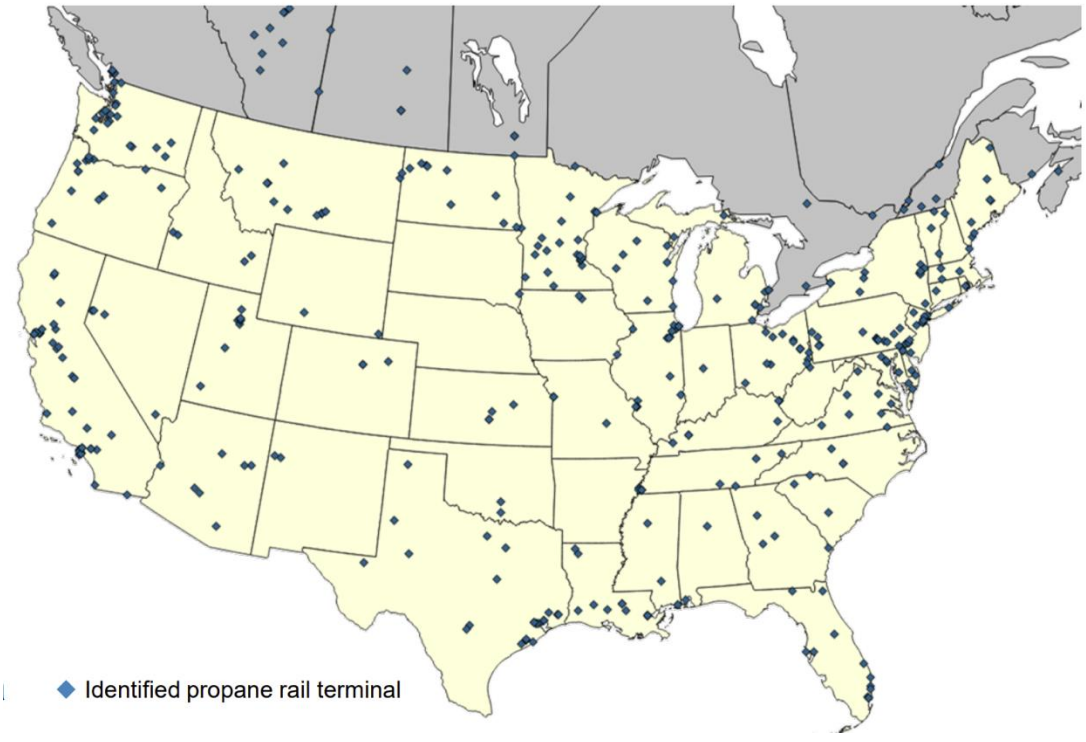



[18] EIA, PLG Analysis (September 2023)

**Figure 7: Typical Propane Flow From Local Terminal to Residential Consumer[19]**

Because of propane's varied and geographically diverse production, fractionation, and end use locations, **rail plays a major role in its transportation**. This includes large volumes of propane by rail movements that cross the Canadian border to serve US markets, shipments to export ports on the east, west, and Gulf coasts, and deliveries to hundreds of rail/truck propane terminals throughout the US and Canada from which "final mile" distribution takes place to homes and businesses. Rail is the main way in which Canadian propane is transported to markets.[20]

**Figure 8: Identified Propane Rail Terminals[21]**




[19] Industrial Propane Service, Superior Energy Systems, Godfrey Propane Co., PLG Analysis (September 2023)
[20] Canada Energy Regulator, *Rail is the main way to transport Canadian propane to markets* (June 2020)
[21] EIA, *Propane Market Fundamentals* (November 2019)

More than 68,000[22] high capacity pressurized railroad tank cars are involved in this service in North America, and the annual volume of shipments in these pressurized carloads (including other NGLs) exceeds well over 300,000 carloads per year[23]. And, because of this widespread use of rail for propane distribution, virtually all of the major fractionation facilities and underground storage caverns for propane in North America are rail-served.

Rail is a primary means of propane transportation in North America.

**Figure 9: Canada Propane and Butanes Exports by Mode of Transportation[24]**

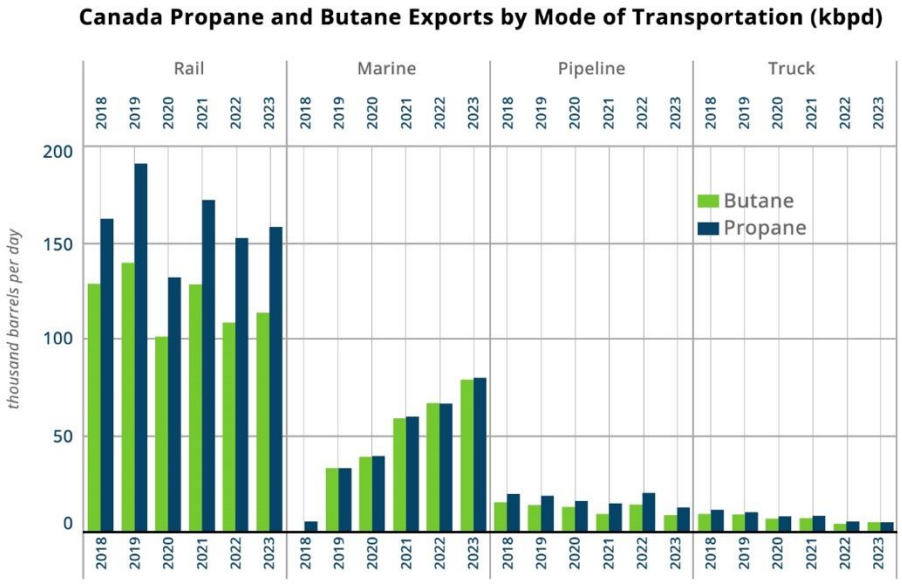
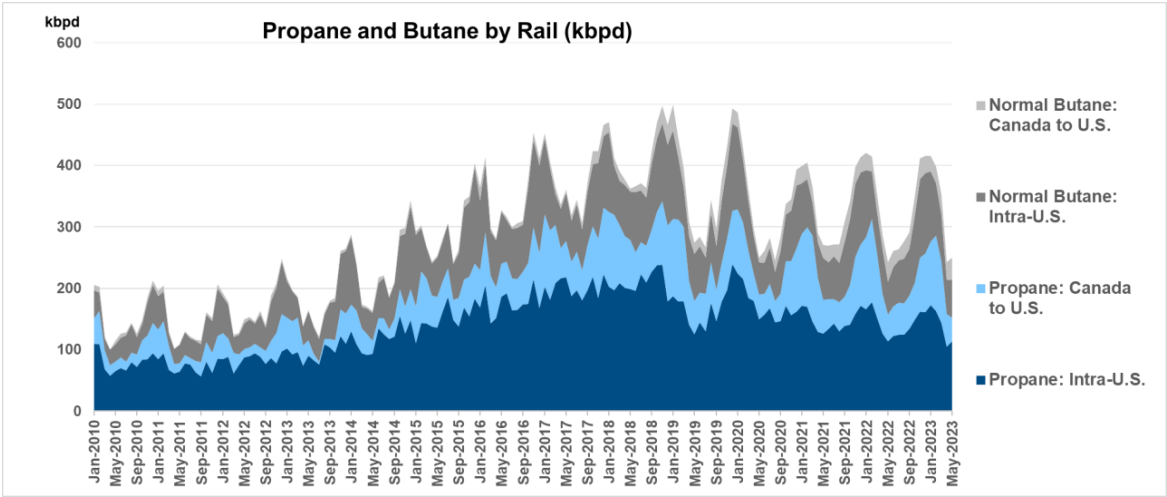


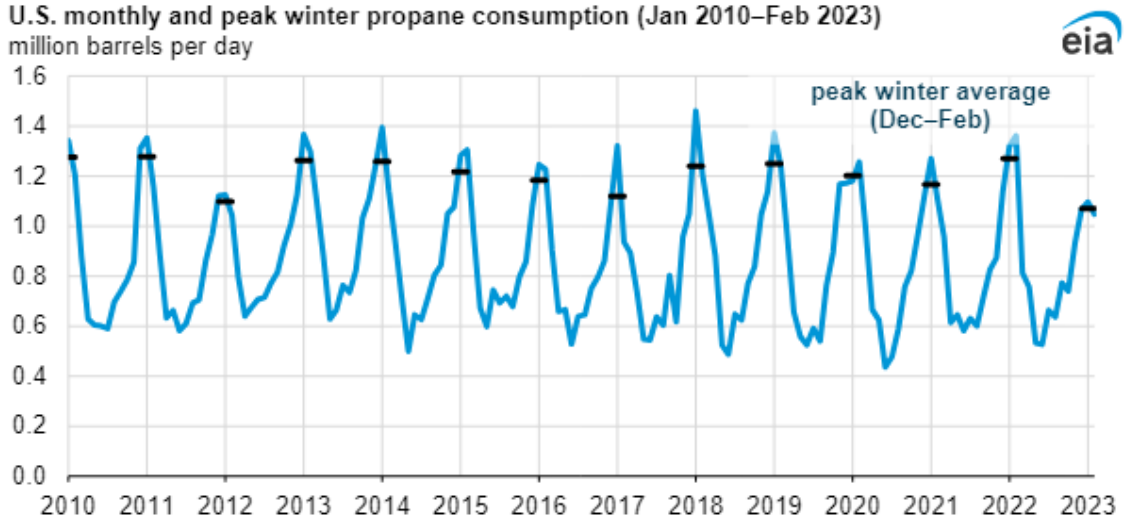

**Figure 10: U.S. Propane and Butane by Rail[25]**




[22] Railinc, *Umler,* PLG Analysis (October 2022)
[23] STB, Canada Energy Regulator, PLG Analysis (September 2023)
[24] Canada Energy Regulator, *Propane and Butanes Exports by Mode of Transportation* (August 2023)
[25] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023)

As illustrated in Figure 11, the propane business is highly seasonal. For this reason, underground storage plays an essential role in propane distribution. Home heating is obviously required during wintertime while grain drying occurs during the fall following harvest season. Only industrial uses for propane, as well as exports, are steady year-round. This means that while extraction of Y-grade and fractionation into purity products is taking place constantly, the actual consumption of propane mostly happens in the fall, winter, and spring. This requires transport of propane from fractionators to large scale storage, consisting of underground salt caverns as well as above-ground cylindrical and spherical tanks that can hold the product until it is needed. In most cases, fractionation capacity is co-located with underground storage.

**Figure 11: U.S. Winter Propane Consumption[26]**




Underground salt caverns for NGL storage pump brine to create positive or negative displacement, depending on whether the product is being discharged or stored. As demand for propane builds during the fall, the product is taken from storage and loaded onto railcars for furtherance to residential, agricultural, and industrial customers. In some cases industrial users will have pipeline connectivity with storage facilities, depending on proximity. Both rail and pipeline modes are also used to transport propane for export on both the US east and Gulf coasts, while rail is the exclusive mode for west coast exports.

Taken together, the disparate production areas, transport connectivity, demand areas, and seasonality for propane create major commodity flows across the continent that vary between warmer times of the year and the peak "heating" demand season. The general differences in those commodity flows that are germane to the Line 5 market region and production areas are represented in Figures 12 and 13 below:

[26] EIA, *U.S. propane consumption last winter was the lowest since at least 2010* (May 2023)

**Figure 12: High-Level Overview of Major Propane Commodity Flows For Winter Demand Season[27]**

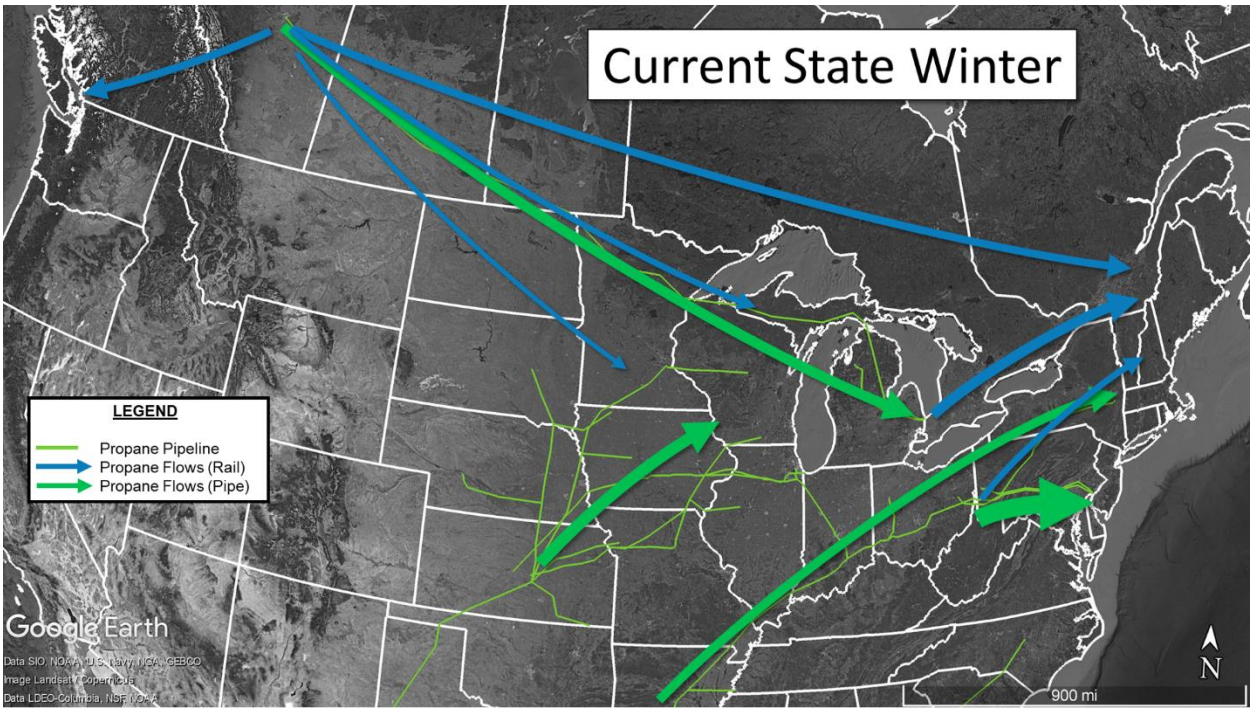
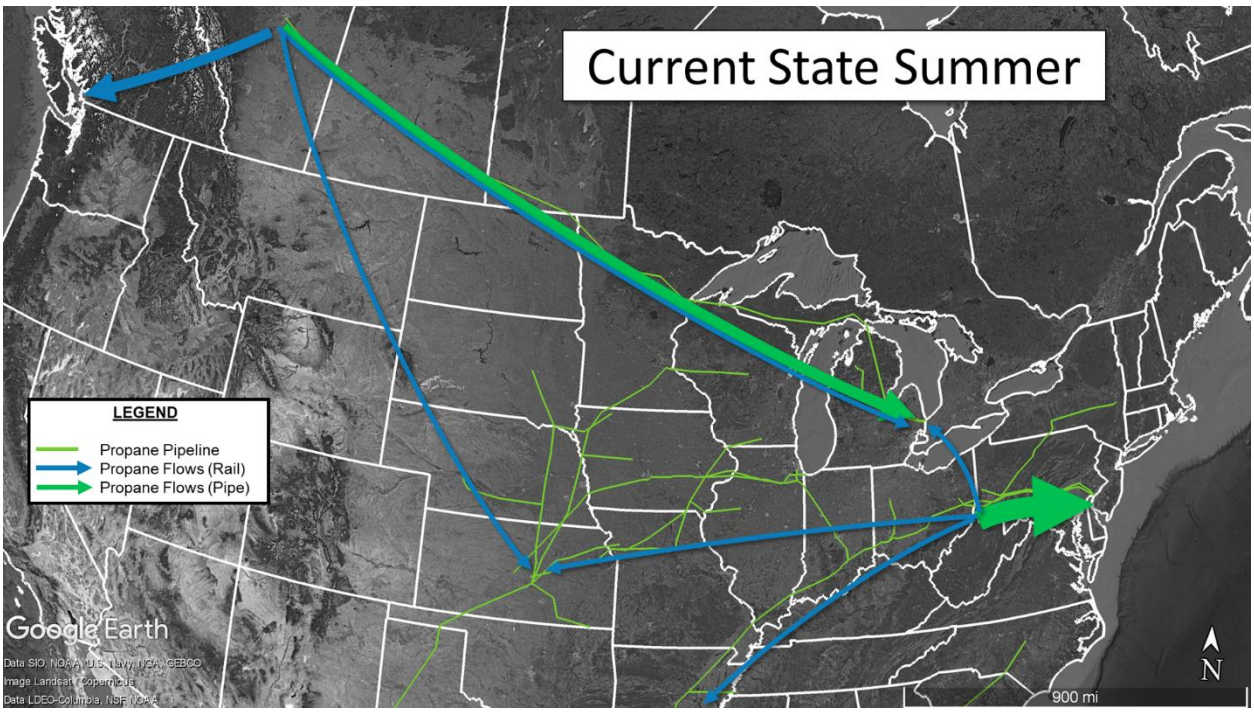



**Figure 13: High-Level Overview of Major Propane Commodity Flows For Summer Season[28]**




[27] EIA, Google Earth, PLG Analysis (September 2023); not all routes shown
[28] EIA, Google Earth, PLG Analysis (September 2023); not all routes shown

In the case of butane, its primary end use is as a seasonal, inexpensive blending component of gasoline which increases the vapor pressure to help spark plugs ignite the fuel in cold temperatures[29]. As such, butane is needed at refineries, so from fractionation sites it is transported either via truck, rail, or pipeline. Similar to propane, excess butane production is stored awaiting "blending season." In addition to exports, butane is used year-round as a chemical feedstock and as a propellant. The total volume of butane consumed in the US is relatively small – only 209 kbpd[30]. The demand for butane is expected to decrease over time as both light duty vehicle fuel efficiency standards and market share of electric vehicles (EVs) continues to grow.

### The Resiliency and Adaptability of Energy Supply Chains

Across the spectrum of hydrocarbon commodities and products – crude oil, refined products, dry natural gas, NGLs – throughout their history **the supply chains of these products have been marked by a high degree of flexibility and adaptability.** At times such adaptations have been necessary in order to ensure reliability of supply or reflect changing patterns of production and consumption. In other cases those adaptations have been opportunistic, because the large and consistent volumes of these commodities makes creation of new logistics routes, systems, and infrastructure to support changing commodity flows economical within a relatively short amount of time.

Some examples of this supply chain dynamism from recent times include

- The rapid development of crude by rail from the Bakken region in North Dakota and Montana, wherein more than a dozen loadout facilities were built within a few years starting around 2012 in order to enable market access to the Midwest, Gulf Coast, and West Coast refineries for surging production

- The similar and simultaneous build-out of both outbound crude by rail and inbound diluent[31] by rail capacity in western Canada to serve rapidly increasing production demands

- The reversal and repurposing of the Kinder Morgan Cochin pipeline in 2014, which changed the pipeline from moving propane eastward from Fort Saskatchewan, AB to Windsor, ON to transporting condensate westward on the segment on the pipeline from Kankakee, IL to Fort Saskatchewan, AB[32].

The Cochin pipeline reversal example is particularly relevant to the topic of this report. This 76 kbpd pipeline had previously handled propane for distribution at various terminals in several midwestern states, including Wisconsin, but in 2012 its owner Kinder Morgan announced plans to reverse the pipeline and instead utilize it for transport of condensate from the Midwest to Alberta diluent markets. The reversal took 24 months from the time of announcement and 12 months from the time of regulatory

[29] Due to vapor pressure regulations in both Canada and the US, butane is only used for gasoline blending seasonally from Sep. 15 - Mar. 15.
[30] 2022 "Refinery & Blender Net Inputs" of 186 kbpd + "Products Supplied" of 23 kbpd = 209 kbpd (EIA, *Supply and Disposition of Crude Oil and Petroleum Products* (August 2023))
[31] Diluent is the use of very light hydrocarbons such as condensate or natural gasoline as a blend with heavy crude in order to facilitate flow of that crude in pipelines and also ease the discharge process from tank cars
[32] Canada Energy Regulator, *Pipeline Profiles: Cochin Pipeline* (December 2021)

approval, and with that advance notice the industry developed several new rail terminals to provide an alternative supply chain solution for the affected region. By the time the reversal took place, several new rail facilities for propane receipt had been built in a number of states. The Cochin Pipeline reversal is an example of the industry successfully building the necessary infrastructure and transitioning to alternative modes of supply after receiving advance notice of a pipeline alteration.

Another example of the flexibility and adaptability of energy supply chains is the permit denial of the Keystone XL crude oil pipeline, which was intended to expand the existing Keystone pipeline network using a new corridor with capacity for 830 kbpd to deliver Canadian oil sands and US Bakken shale crude between Alberta and an existing pipeline hub at Steele City, NE. First announced in 2008, the Keystone XL project was beset by its own legal and policy disputes, with regulatory, judicial, legislative, and cabinet-level approvals, denials and delays that spanned four presidential administrations.[33] But between the announcement of the project in June, 2008 to its final permit revocation by President Biden in January 2021 and subsequent project abandonment by its developer TransCanada in June 2021, the energy industry did not sit on its hands. Even without Keystone XL, oil production was able to grow in Western Canada and the Bakken due to a range of alternative pipeline routes and expansions providing takeaway capacity, including expansion of the Enbridge main line and the development of the Dakota Access Pipe Line (DAPL). In addition, crude by rail played a key role in providing transportation of Canadian oil to markets, especially during the 2018-2019 time period in which production was exceeding pipeline takeaway capacity and rail was able to handle nearly 450 kbpd (Figure 38). And as discussed later in this report, 590 kbpd of new pipeline capacity is about to come online by the end of 2023 with the TransMountan Expansion project that will further enable Western Canadian crude to access key markets.

Hydrocarbon supply chains are highly flexible, adaptable, and resilient.

Perhaps one of the most dramatic recent examples of the innate flexibility and resiliency of energy supply chains is the abrupt shutdown of the Nord Stream pipeline following Russia's war on Ukraine that began in February 2022. While the shocking circumstances of that aggressive action resulted in a period of increased prices and concern about energy security, the European continent was able to adapt through the winter of 2022-2023 through a combination of coordinated and rapid responses. Those initiatives included:

- Diversion of US LNG cargoes from Asian destinations to Europe, combining with increased LNG shipments from West Africa and Qatar[34]
- Use of floating LNG docks that allowed for receipt of those cargoes without having to build fixed terminal infrastructure[35]
- Replenishment of natural gas storage caverns, which happened to be at historic lows at the time that Russia's invasion of Ukraine began.

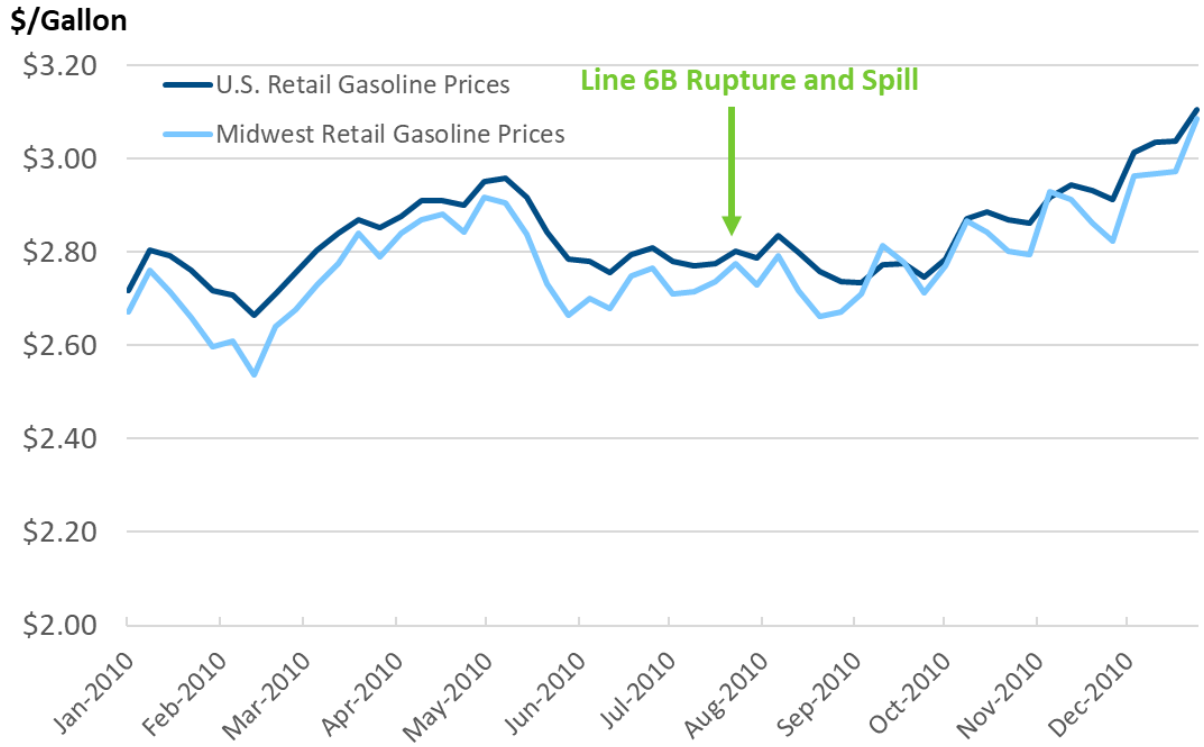
As a result of the elastic and resilient supply chain responses to the supply disruption caused by the war in Ukraine, the war-related increase in European gas prices was shorter than might have otherwise been

[33] Ballotpedia, *Keystone XL Pipeline political timeline* (Retrieved September 2023)
[34] RBN Energy, *Hazy Shade Of Winter – European Gas Markets Avoided Mayhem This Winter, But Challenges Remain* (March 2023)
[35] RBN Energy, *Float On - Europe Seeks FSRUs To Boost LNG Import Capacity, And Fast* (July 2022)

expected given the sudden development of the conflict as well as the subsequent sabotage to the Nord Stream pipelines, with one and four month surges in prices resulting from each development, respectively. But by November of 2022 prices had normalized to pre-invasion levels and Europe has been able to even further diversify its supply of natural gas through enhanced intra-continental pipeline connectivity and cooperation with regional partners, particularly Algeria.[36]

The innate flexibility of hydrocarbon energy supply chains was also demonstrated in July 2010, when Enbridge's Line 6B (now designated as Line 78) experienced a rupture and spill in Marshall, MI. Even though this resulted in the complete shutdown of the pipeline for two months, no supply shortages or price spikes (as shown in Fig. 15) affected the 6B delivery area of Michigan, Ontario, and Ohio because of the existing overlap of supply sources and delivery routes that characterize nearly all of the crude, refining, and refined products ecosystems in North America.

**Figure 14: Midwest and U.S. Gasoline Prices Through Period of Line 6B Spill[37]**

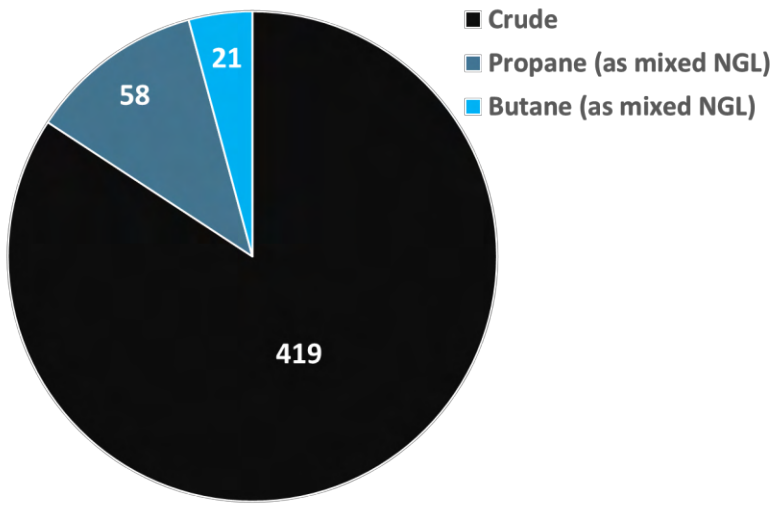



[36] Wall Street Journal, *The Unexpected New Winners in the Global Energy War* (September 2023)
[37] EIA, *Weekly Retail Gasoline and Diesel Prices*, PLG Analysis (September 2023)

# II. OVERVIEW OF LINE 5

First constructed 70 years ago, Line 5 is part of Enbridge's Lakehead System, a network of pipelines in the Great Lakes region of the United States. It is fed by Enbridge pipelines originating in Western Canada. Line 5 transports crude oil and natural gas liquids east, from Superior, Wisconsin, to Sarnia, Ontario. It conveys between 400,000 and 450,000 barrels per day (bpd) of crude oil, in addition to about 80,000 bpd of NGLs[38].

**Figure 15: Total Products Handled by Line 5 (kbpd)[39]**




As detailed below, crude oil handled by Line 5 combines with a larger supply of oil from various modes and sources that supports ten refineries in Quebec, Ontario, Pennsylvania, Ohio, and Michigan. The NGLs transported by Line 5 are a mix of propane and butane, with small amounts of propane removed at Superior, WI and Rapid River, MI and the butane and vast majority of the propane terminating at Sarnia, ON.

[38] Expert Reports of Sarah Emerson of ESAI and Neil Earnest of Muse, Stancil & Co. (January 2022) in *Bad River Band v. Enbridge*

[39] Expert Reports of Sarah Emerson of ESAI and Neil Earnest of Muse, Stancil & Co. (January 2022)

**Figure 16: Enbridge Line 5, Associated Pipelines, Fractionators and Refineries**[40]


## Crude Oil Markets Supplied by Line 5

**It is essential to understand that no refinery relies entirely upon Line 5 for its supply of crude.** When it comes to crude oil, the Line 5 delivery area is in actuality served by the combination of Line 5 plus Enbridge's Line 78 from Griffith, IN, which joins with Line 5 to supply ten refineries—three in the Detroit-Toledo area, four in Ontario, two in Quebec, and one in Pennsylvania. Fed by Enbridge pipelines that flow south from Superior, WI to its origination point in the Chicago area, Line 78 flows east from Griffith, IN to Sarnia. Like Line 5, Line 78 itself is also fed by Enbridge's Mainline system from western Canada, but in combination with other pipelines runs around the south end of Lake Michigan rather than over the top (north) of Lake Michigan as is the case with Line 5. After Line 78's contribution plus that of other transport modes already in use, Line 5 only constitutes a minority of the total volume of crude oil delivered to the area.[41]

No refinery relies entirely upon Line 5 for its supply of crude oil.

[40] Enbridge, PLG Analysis (September 2023)
[41] Expert Report of Sarah Emerson of ESAI (January 2022), PLG Analysis

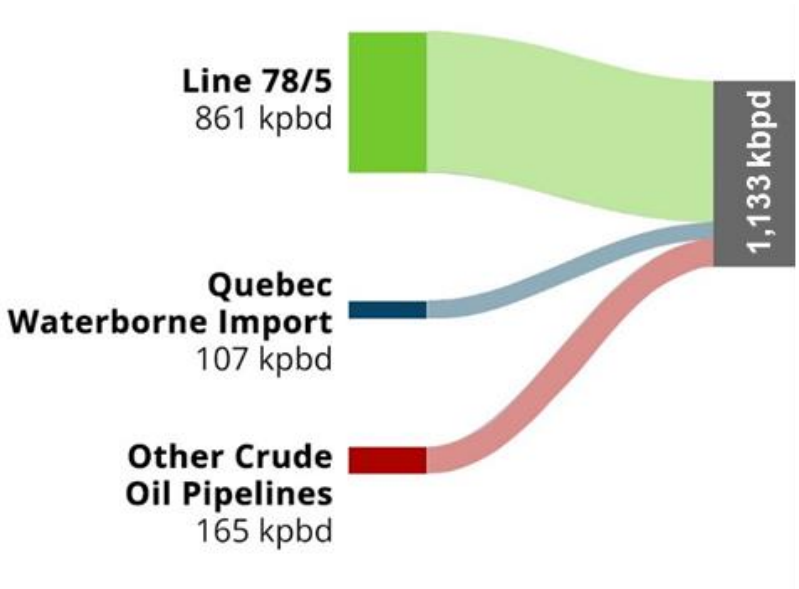
**Figure 17: Estimated Pipeline Supply From Lines 78/5 to Ten Refineries in 2021 (Q1-Q3)[42]**

| Refinery | ex-line 78/5 (kbpd) |
|---|---|
| Sarnia - Imperial | 102 |
| Sarnia - Shell | 74 |
| Sarnia - Suncor | 77 |
| Nanticoke - Imperial | 95 |
| Montreal - Suncor | 125 |
| Quebec City - Valero | 76 |
| Detroit - Marathon | 82 |
| Toledo - PBF&BP | 166 |
| Warren, PA - United | 64 |
| **2021 Total** | **861** |

Several of the refineries in question do not receive crude oil directly from Lines 78/5, but rather from downstream connecting pipelines. For example, as illustrated in Figure 16 above, the Suncor refinery in Montreal receives crude oil via Line 9, which is fed by Lines 78/5. And to get crude oil the additional several hundred miles from the end of Line 9 in Montreal to the Valero refinery in Quebec City, oil from Line 9 is loaded into a ship and transported via an inland waterway connecting the cities. Also, as explained later in this report, the Quebec refineries' use of Line 78/5-supplied crude is a relatively recent phenomenon. Prior to its reversal in December 2015, Line 9 actually flowed east-to-west, which enabled waterborne deliveries of crude to not only satisfy the needs of the Quebec refineries but also to supply those refineries further inland within the Line 78/5 service area.

Thus, as illustrated in the schematic in Figure 18 below, Line 5 is just one part of a larger pool of about 1.1MM bpd of crude oil supply meeting the needs of the ten refineries in question. And, as explained later in this report, there are a multitude of alternative sources and delivery means for crude supply to the refining area in question.

**Figure 18: Current Crude Oil Supply Chain for Line 5-Related refineries**



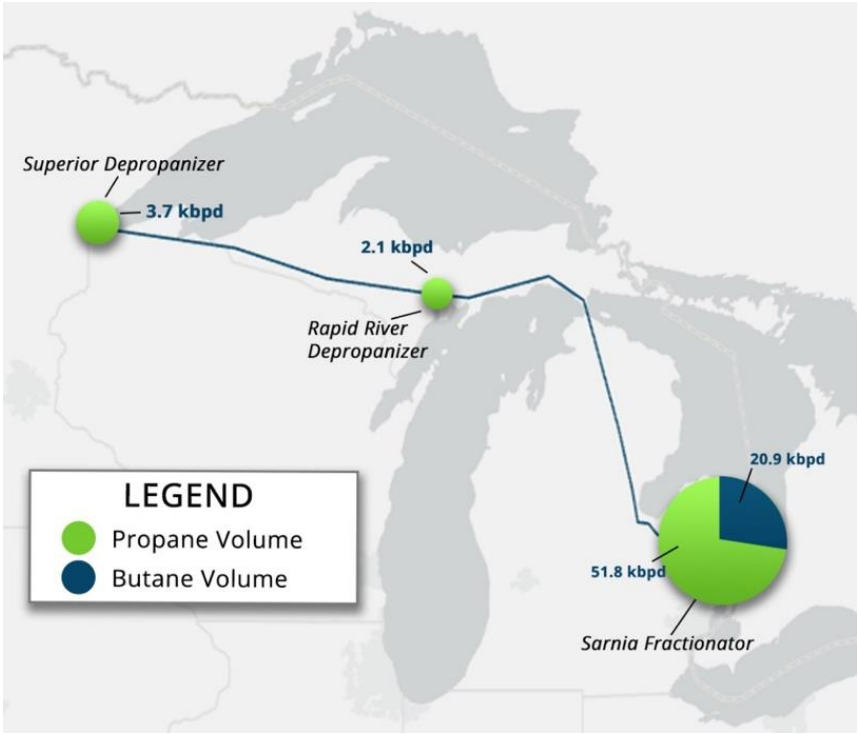

Line 5 is just one component of the larger crude supply to the region, for which there are several alternatives.

[42] Expert Report of Sarah Emerson of ESAI (January 2022); Based on 2021 Q1-Q3 Enbridge data; Note that other pipelines also supply the market region

## NGL Markets Supplied by Line 5

As summarized earlier, Line 5 presently transports a mixed NGL stream consisting of propane and butane. Line 5 directly connects to three fractionators that separate out the mixed NGLs (propane and butane) handled by Line 5 into purity products. The three fractionators are located in Superior, WI, Rapid River, MI, and Sarnia, ON. The fractionator in Superior receives NGLs consisting of a mix of propane and butane from Enbridge's Line 1. It separates out approximately 3,700 bpd of propane to sell to local propane retailers and injects the separated butane back into Line 5. The Rapid River fractionator in the Upper Peninsula of Michigan separates out approximately 2,100 bpd of propane from the NGL stream, with the remaining butane again conveyed along with the rest of the NGL stream to Sarnia. These two fractionators at Superior and Rapid River are also sometimes referred to as "depropanizers," as they only separate out propane whereas more complex fractionators will separate out ethane, propane, butane and pentane.

**Figure 19: Line 5 Fractionators with Propane and Butane Throughput[43]**




The bulk of the propane plus all of the butane terminates at the Plains-Sarnia fractionator, where it is separated and injected into storage caverns for eventual loading onto railcars for furtherance to retail and agricultural customers. Some of the propane is also delivered locally in Sarnia to industrial customers. The majority of the propane consumed in Wisconsin and Michigan is used for residential heating. Fractionation at Sarnia yields 51.8 kbpd of propane and 20.9 kbpd of butane[44]. Most of the propane produced by the Sarnia fractionator is sold in Ontario, Eastern Canada and the Northeast U.S. with about 13,000 bpd sold in the Lower Peninsula of Michigan. Butanes are primarily utilized by refineries locally as fuel or as an additive to gasoline.

Propane and butane have seasonal demand, so large storage is beneficial as it allows stockpiling in the offseason from distant supply sources and prior to shipment during the peak season of winter. There are 32,555,000 barrels of underground NGLs storage capacity in Michigan and Sarnia-Windsor, ON as illustrated in Figure 20.

[43] Total NGL volume of 82 kbpd on Line 5 and 70.2% is propane = 57.6 kbpd of total propane; 57.6 – 3.7 (Superior) – 2.1 (Rapid River) = 51.8 kbpd of propane delivered to Sarnia (Expert Report of Neil Earnest (January 2022)), Expert Rebuttal Report of Jill Steiner (April 2022), and Jill Steiner Testimony (October 2022))

[44] The remaining 3.0 kbpd of NGLs on Line 5 are ethane and natural gasoline (Expert Report of Neil Earnest (January 2022))

**Figure 20: Michigan and Sarnia-Windsor Area NGL Storage Caverns**[45]

**Hydrocarbon Gas Liquids Underground Storage Capacity**

| Owner/Operator | Location | Underground Storage(bbls) |
|---|---|---|
| Plains Midstream | St. Clair, Michigan | 2,000,000 |
| DCP Midstream | Marysville, Michigan | 8,000,000 |
| Marathon Petroleum | Woodhaven, Michigan | 1,755,000 |
| Plains Midstream | Alto, Michigan | 1,300,000 |
| Sunoco Logistics | Inkster, Michigan | 800,000 |
| **Michigan Total** | | **13,855,000** |
| Plains Midstream | Windsor, Ontario | 4,700,000 |
| Plains Midstream | Sarnia, Ontario | 5,800,000 |
| Alberta Ltd ( Pembina ) | Corunna, Ontario | 5,200,000 |
| Suncor Energy Products | Sarnia, Ontario | 1,180,000 |
| Imperial Oil | Sarnia, Ontario | 1,820,000 |
| **Sarnia- Windsor, Ontario Total** | | **18,700,000** |

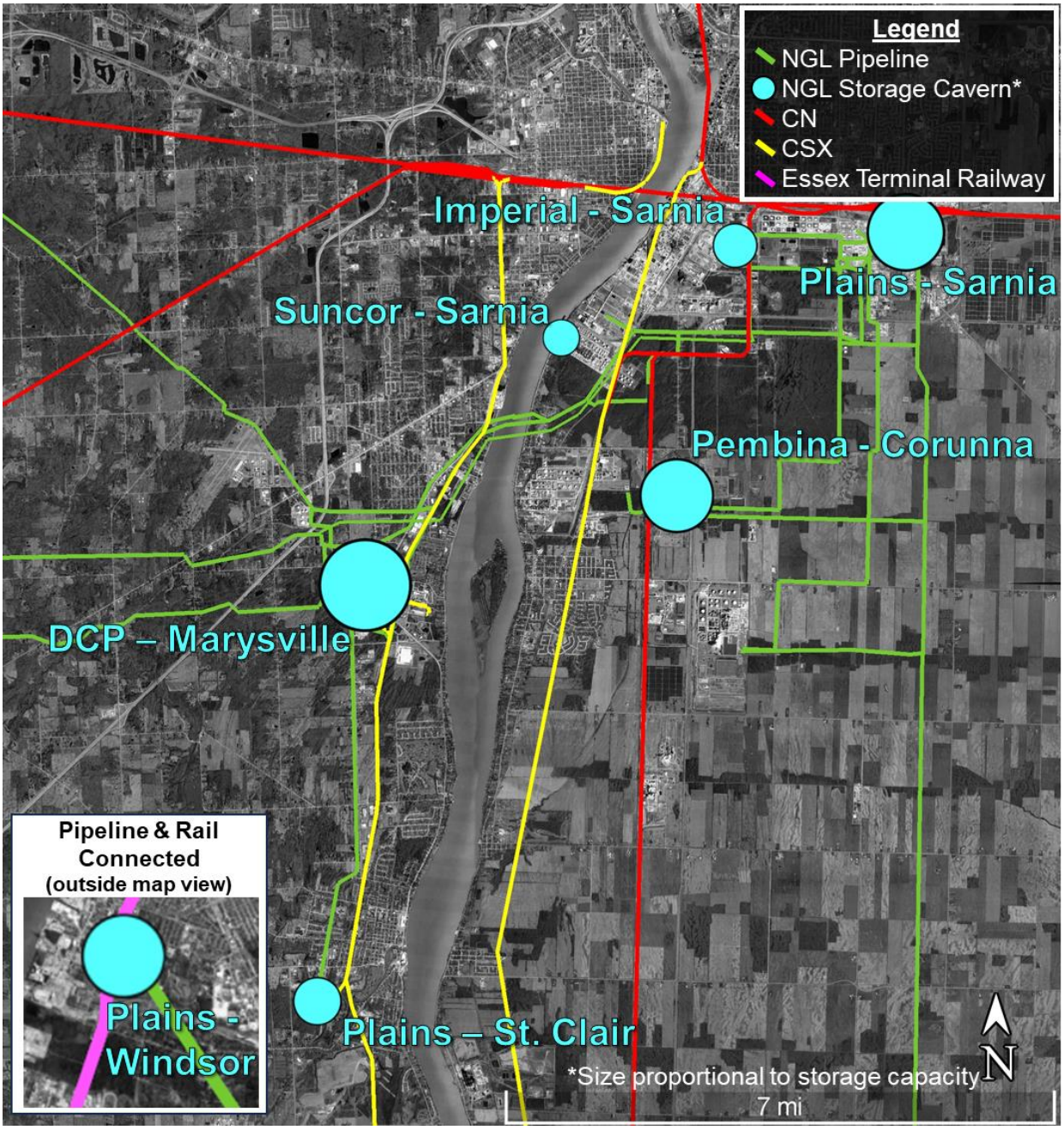
source: Upper Peninsula Energy Task Force

**Most of the underground NGLs storage facilities in the Sarnia/Port Huron/Windsor area and in Michigan are both served by rail and connected by pipeline**, providing robust interconnectivity both locally and to the continental rail network.

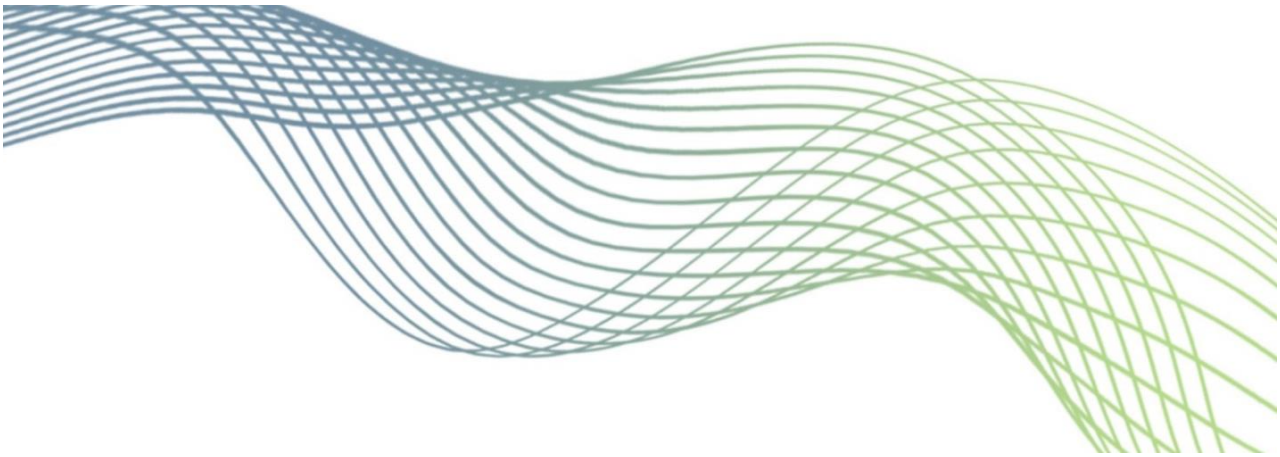
All of the major NGL storage caverns in the Sarnia/Port Huron/Windsor area are served by rail.

[45] Michigan Public Service Commission (MPSC), *Michigan Statewide Energy Assessment* (September 2019)

**Figure 21: Sarnia/Port Huron/Windsor Area NGL Storage Caverns, Pipelines, & Key Rail Lines [46]**




[46] PHMSA, MPSC, Canada Energy Regulator, PLG Analysis, August 2023



# III. ANTICIPATED MARKET RESPONSE IN THE EVENT OF A LINE 5 SHUTDOWN

To reiterate, PLG makes no opinion regarding the legal and policy disputes that may or may not prompt a shutdown of Line 5. However, the analysis in this report, based on industry experience as well as the proven history of the how energy producers, traders, and logistics providers have consistently reacted to ever-changing market conditions and opportunities indicates that **with sufficient notice of a shutdown, Line 5 area products and markets will adapt without supply shortages or extreme price spikes.**

Confidence in this position is due not only to the inherent flexibility and resiliency of hydrocarbon supply chains as described earlier, but also due to several of the specific characteristics and circumstances of Line 5 area products and markets. Those characteristics and circumstances, which this report explains in detail, include:

1. **Line 5 delivery area markets have access to multiple alternative sources of crude, refined products, and NGLs.** While Line 5 has provided a homogenous supply of crude and mixed (propane and butane) NGLs from Western Canada for several decades, the affected markets have multiple alternative sourcing options from which to choose should Line 5 shut down. For example,
    - Waterborne light/sweet crude supplies could be sourced from the US Gulf Coast, Guyana, West Africa, or the North Sea
    - Bakken light/sweet crude is available via both rail and pipeline delivery
    - The NGL-rich Marcellus/Utica shale play in Pennsylvania and Ohio is both one third the distance from Sarnia and Sarnia-served markets as Alberta, and also one of the largest propane production areas in North America.

Numerous alternative sources of supply are available to Line 5 markets.

2. **The logistics infrastructure, systems, modes, networks, terminals, rolling stock, and routes largely already exist and in sufficient capacity to provide delivery of alternatively-supplied crude**

**and NGLs to the Line 5 market area.** In fact, those logistics and transportation systems can also help to preserve Alberta's role in continuing to supply energy resources to the Line 5 market area should customers desire it.

## Much of the required logistics infrastructure, networks, and equipment already exists to provide alternative supply chain solutions for Line 5 products and markets.

3. **The companies participating in Line 5 products and markets are sophisticated and large energy firms that regularly evaluate and anticipate risks and market changes.** Therefore, it's not surprising that **for at least the past six years contingency plans have been developed** by key refiners and other businesses whose supply chains may be altered in the event of a Line 5 shutdown. Several of those market players, including Suncor, Valero, and Imperial, have stated publicly that they have contingency plans in place that when executed upon will preserve their ability to operate and meet the needs of their end-use customers[47][48]. As such, while planning is an obvious step in the transition of any supply chain, it is already known that planning for the potential shutdown of Line 5 has already taken place and alternative solutions are ready to be implemented.

## Major market players have already developed contingency plans for a potential Line 5 shutdown.

**The combination of these characteristics and circumstances are why there are a range of <u>commercially viable</u> and <u>operationally feasible</u> supply chain alternatives for each of the end use destinations and markets that would be affected by a Line 5 shutdown.**

**Commercially viable** means that while total delivered costs of new alternative supply chain solutions may not be the exact same cost as today, any increases in costs would be nominal and would not materially affect the affordability or market competitiveness of product delivered to any given Line 5 destination area. In addition, if any new capital investments were to be used to provide such alternative supply chain(s), that investment would have both a reasonable payback period and no shortage of interested investors and/or service providers seeking to provide such alternatives.

**Operationally feasible** means that none of the alternative supply or logistics solutions would involve any unusual or novel approaches, equipment, facilities, or technology; in fact most of such alternative solutions would utilize methods and approaches either already in use for Line 5 products and markets or ones that had previously been a primary source and means of supply to select Line 5 product destinations within the recent past.

The following section of this report provides an analysis of the multitude of alternative supply chain solutions for Line 5 products and markets, presented separately for

[47] Financial Post, *Suncor, Imperial scramble to make contingency plans in case Michigan's order cuts off Ontario's oil supply* (February 2021)
[48] The Canadian Press, *Quebec's location and energy alternatives give it options if Line 5 closes: expert* (May 2021)

1) crude oil (and, as appropriate, the downstream delivery of refined products that are derived from the refining of crude oil); and

2) NGLs, specifically the relevant purity products propane and butane.

The analysis for each commodity is further broken down to identify the commercially viable and operationally feasible solutions according to three phases:

**Phase I solutions are those that can be implemented almost immediately (i.e. within three months), without major capital investment.** Most of these solutions are already currently supplying the Line 5 area, and would only need to increase volume. While all identified Phase I solutions are able to be commence operations almost immediately (i.e. within three months), in some cases those solutions may need additional months to "ramp up" to achieve full potential volume.

**Phase II solutions are those solutions likely requiring 12-18 months for implementation and/or nominal capital investment before commencing operations.**

**Phase III solutions are ones that the industry may choose to pursue to enhance throughput, efficiency, and/or additional optionality over a longer period of time.**

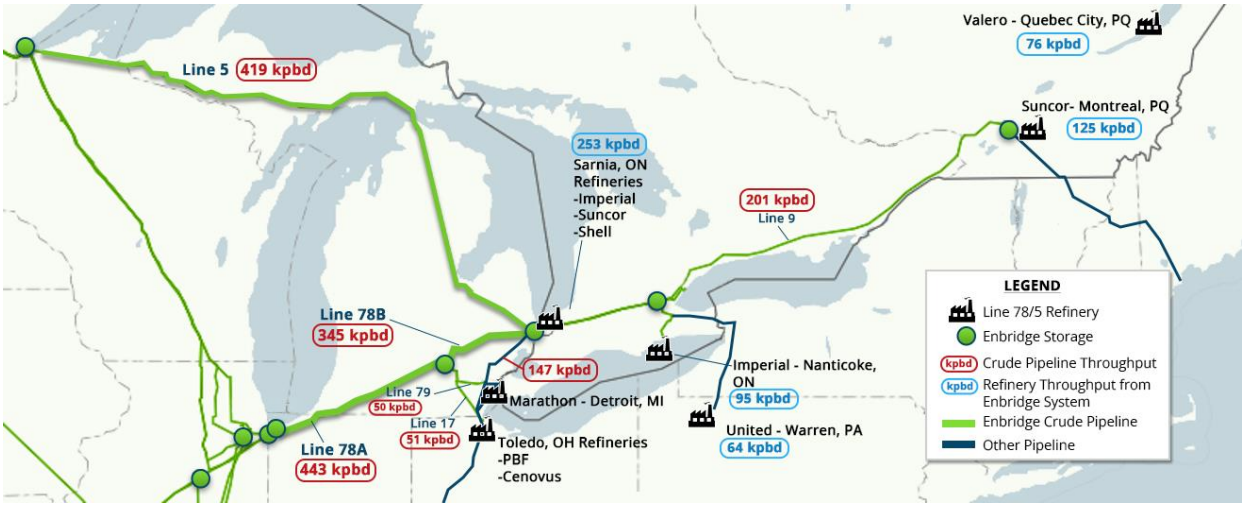
It is important to emphasize that for all products and markets, Phase I and Phase II solutions together are able to satisfactorily provide commercially reasonable and operationally feasible alternative supplies of Line 5 products to affected facilities and areas with 100% of the required replacement volume. Phase III solutions are provided herein merely to enumerate the several additional steps that could be taken over a longer timeframe to provide supply, and further illustrate the myriad of options that exist.

# IV. OVERVIEW OF ALTERNATIVE SUPPLY CHAIN OPTIONS FOR LINE 5 PRODUCTS AND MARKETS

## Crude Oil

In the event of a Line 5 shutdown, the supply of crude oil presently handled via Line 5 would be replaced by a combination of solutions with overlapping optionality and resiliency. It is important to reiterate that Line 5 combines with Line 78 to provide some of the pipeline connectivity for the affected refineries, and that connectivity would continue even in the event of a Line 5 shutdown. Figure 22 provides the estimated throughput volume of Lines 5, 78, and 9, as well as the volume that each refinery or refinery area receives from those pipelines.

**Figure 22: Estimated Crude Oil Flows of Line 5, Line 78, and Downstream Pipelines[49]**




[49] Expert Report of Sarah Emerson of ESAI (January 2022), PLG Analysis

The ten refineries within the Line 5 service area are summarized in Figure 23, inclusive of current capacity for each refinery, the share of each refinery's supply that is provided by the combined Line 78/5, existing alternative supply sources, and logistics connectivity (even if not all of that connectivity is presently used today):

**Figure 23: Line 78/5 Related Refineries Crude Oil Sourcing**[50] [51] [52] [53]

| Refinery | Est. Volume Supplied by Lines 78/5 (2021 Q1-Q3, kpbd) | Refining Capacity (kpbd) | Other Crude Sources & Delivery Logistics Currently Used | Other Crude Sources & Delivery Logistics Available but not Currently Used |
|---|---|---|---|---|
| Sarnia- Imperial | 102 | 119 | Rail to Truck through VIP Sarnia | - |
| Sarnia- Shell | 74 | 77 | - | - |
| Sarnia- Suncor | 77 | 85 | - | - |
| Nanticoke- Imperial | 95 | 114 | - | Rail at Refinery |
| Montreal- Suncor | 125 | 137 | Portland- Montreal Pipe, Waterborne | - |
| Quebec City- Valero | 76 | 235 | Waterborne | Rail at Refinery |
| Detroit- Marathon | 82 | 140 | Patoka & Mid-Valley Pipelines | - |
| Toledo- Cenovus | 166 | 149 | Patoka & Mid-Valley Pipelines | - |
| Toledo- PBF | | 173 | Patoka & Mid-Valley Pipelines, Truck | Rail to Truck through MT |
| Warren,PA- United | 64 | 65 | - | - |
| **Total** | **861** | **1,294** | | |

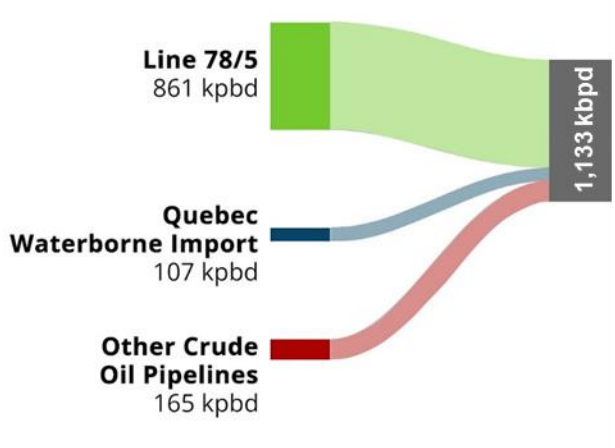
Line 5's contribution to the crude oil supply for the region makes up only about 1/3 of the total demand of about 1.3MM bpd, which is met by other pipelines as well as other delivery modes.

Although the nameplate refining capacity of the ten refineries is approximately 1.3MM bpd, the actual amount of crude oil feedstock that is refined by those refineries is about 1.1MM bpd.

The schematic in Figure 24 illustrates the overall logistics flows of that crude oil with share by mode. Across all of the modes and refineries, the weighted average cost per barrel delivered for the region is $85.84/bbl (Figure 43).

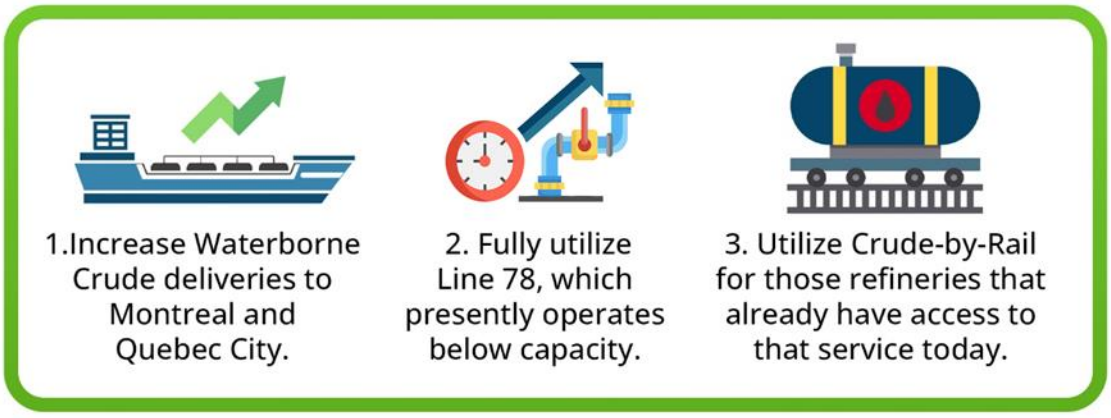
[50] Expert Report of Sarah Emerson of ESAI (January 2022), PLG Analysis
[51] EIA, *Refinery Capacity Report* (June 2023)
[52] Canada Energy Regulator, *North American Crude Oil Refinery and Upgrader Capacity* (July 2022)
[53] Valero Energy Corporation, *Form 10-K 2022* (February 2023)

**Figure 24: Current Crude Supply of Line 78/5 Related Refineries[54]**




## Phase I Immediate Term (within three months) Alternative Supply Chain Solutions for Crude Oil

In the event that Line 5 and the 419 kbpd of light crude oil[55] that it contributes to the combined Line 78/5 delivery system were to cease operations, **there are three primary initiatives that can be undertaken almost immediately and with no new capital infrastructure requirements that would make up all but about 53 kbpd, or 13% of Line 5's contribution.** Those three initiatives are:




A detailed review of each of these initiatives is provided below. However, it is critical to note that while the three initiatives described for Phase I are intended to replenish the supply of crude oil to refineries that would be affected by a Line 5 shutdown – and are in fact able to replenish 87% of the shortfall within three months – an additional

Refined products delivered from other regions can backstop loss of refinery output in the Line 78/5 region.

[54] Expert Report of Sarah Emerson of ESAI (January 2022), PLG Analysis
[55] Expert Report of Sarah Emerson of ESAI (January 2022)

initiative of bringing in refined products from other areas to the Line 78/5 region is a highly viable backstop for either short or long term use and as such is discussed herein as a Phase I option as well. A discussion of how refined products sourced from other regions can help offset any product availability constraints resulting from a potential Line 5 shutdown is presented later in this report.

1. **Increase waterborne crude deliveries to Montreal and Quebec City, which prior to 2015 was the primary means of crude supply to both refineries.**

The refineries in Quebec (Valero-Quebec City and Suncor-Montreal) already receive crude oil by water. In fact, **Valero-Quebec City receives all of its crude by water,** with well over 100 kbpd from waterborne imports in addition to the 76 kbpd it receives indirectly from Enbridge pipeline system[56] via the loading of vessels at the termination point of Line 9 in Montreal. Suncor-Montreal is taking in a small amount of waterborne crude imports via the Portland-Montreal Pipeline, as well as 125 kbpd received from Line 9. Taken together, fully satisfying all of the Quebec demand with water deliveries will "free up" 201 kbpd[57] (76 plus 125 kbpd) of supply on the Line 78/5 system that would have otherwise been delivered to Quebec via the Lines 78/5 and Line 9 combination. That 201 kbpd can then be made available to the refineries further west on the pipeline network in Ontario, Pennsylvania, Michigan, and Ohio, **by itself solving for nearly half of the crude oil shortfall that would be created in the event of a Line 5 shutdown.**

## Converting Quebec refineries to all-waterborne imports would make up nearly half of a crude shortfall created by a Line 5 shutdown.

It should be noted that, **before late 2015, the Quebec refineries did not receive any crude oil from the Enbridge system.** The Quebec refineries instead obtained their more than 300,000 bpd of crude oil from other sources, primarily waterborne vessels unloading crude oil directly at the refineries or via the Portland-Montreal Pipeline, which moves crude oil from waterborne tankers unloaded in South Portland, ME directly to the Suncor Montreal refinery. Both of the Quebec refinery owners have stated publicly that they have prepared contingency plans for a potential Line 5 shutdown, and touted waterborne deliveries as a key option. Crude-by-rail terminals at each of the refineries have also been used in the past. In addition, Line 9, which presently flows west-to-east, was operated for several decades in an east-to-west direction, transporting waterborne crude inland for use by many of the refineries served by Line 78/5 today.[58]

[56] Valero-Quebec City is not directly connected to the Enbridge system; rather it receives crude oil via tankers that are loaded from the Enbridge pipeline at Montreal and then sailed 155 miles up the St. Lawrence River to its refinery near Quebec City (RBN Energy, *Take A Pipe On The East Side – Feeding Crude To Quebec Refineries* (September 2014))

[57] Expert Report of Sarah Emerson of ESAI (January 2022), PLG Analysis

[58] Canada Energy Regulator, *Pipeline Profiles: Enbridge Line 9* (August 2023)

Prior to 2016, Quebec refineries did not receive any crude oil supplies from the Enbridge System.

Waterborne deliveries of crude to the Quebec refineries can be made in several different ways, reflecting flexibility and resiliency in the supply chain that is typical of North American energy logistics. Those options include direct vessel calls at Valero-Quebec City (which, as noted, are already happening at substantial volumes) and Suncor-Montreal, and/or vessel calls at South Portland, ME for injection into the Portland-Montreal Pipeline which delivers to Suncor-Montreal.

**Figure 25: Portland-Montreal Pipeline System**[59]


Taken together, these waterborne options offer ample capacity to meet the needs of the Quebec refineries and do so almost immediately. That ample capacity is evidenced by, among other things, the Portland-Montreal Pipeline's average throughput of only 7.1 kbpd in the first seven months of 2023, which is just 3% of its 223 kbpd capacity[60]. This ability to provide an immediate term alternative supply chain solution via waterborne imports both satisfies demand in Quebec and also allows those barrels previously consumed from the Enbridge system in Quebec to be made available to the eight other refineries in the affected region. **All this is also accomplished without needing to resort to more involved initiatives such as re-reversal of Line 9, the details of such option being explained later in this report but remaining only a secondary "Plan B" option at most.**

### *Overview of the Tanker Fleet*

The transportation of crude oil and petroleum products by sea is carried out using oil tankers, which are specialized bulk vessels capable of carrying anywhere from a few thousand to over 500,000 metric tons of oil. The fleet is segmented by size of vessel, as these ships typically trade in distinct markets:

•Panamax Tanker: Panamax tankers are between 55 – 85,000 dead-weight tons (DWT), with an approximate cargo capacity of between 300,000 and 400,000 barrels of oil. They are named Panamaxes as their design was the largest oil tanker which could transit the Panama Canal prior to the expansion of

[59] Canada Energy Regulator, *Pipeline Profiles: Montreal* (December 2021)
[60] Canada Energy Regulator, *Pipeline Profiles: Montreal* (December 2021)

the locks in 2016. They are often referred to as "LR1", or "Long Range" tankers, with the fleet largely split into vessels with coatings that can carry "clean" products such as gasoline and naphtha, and those which can carry "dirty" products such as fuel oil or crude oil. Their length and draft are constrained enough that they are suited to trades such as Caribbean, US West Coast and the St. Lawrence Seaway, and can berth at the Valero dock in Quebec. There is an active global fleet of Panamax tankers trading from which an oil trader or refiner could charter to supply crude oil to the Quebec refinery. The Quebec Valero terminal has a maximum DWT capacity restriction of 75,000 MT.

•Aframax tanker: Aframax tankers are between 85,000 – 125,000 DWT. These ships are designed to carry closer to 750,000 barrels and are used in longer haul trades. The Aframax fleet consists of 1,125 vessels with another 124 on order (consisting of 11.5% of the fleet). The vast majority of these ships carry crude oil. The Portland-Montreal Pipeline is capable of taking crude deliveries via Aframax at South Portland, ME.

•Suezmax tanker: Suezmax tankers are between 120,000 – 200,000 DWT. These ships, known for being the largest vessels that can transit the Suez canal, typically carry between 700,000 and 1 million barrels of oil. The Portland-Montreal Pipeline is capable of taking crude deliveries via Suezmax.

### *Optimal Vessel Classes for Calls at Quebec City - Valero*[61]

As stated previously, more than half of Valero-Quebec City's crude oil comes from waterborne crude imports. The refinery can receive Suezmax tanker vessels and currently has Suezmax tankers under time charter for bringing in waterborne crude imports to Quebec City[62]. Ice class[63] vessels for Valero-Quebec City are required seasonally, and additional vessels would be available for this trade. Almost all (if not all) of waterborne crude imports for Quebec City over the past couple years have been Suezmax vessels loading crude in Texas[64]. PLG estimates a cost of $2.80/bbl to move crude from US Gulf to Quebec City, including loading and discharge[65]. Note that Valero has stated publicly it would only cost $2/bbl to transport crude from Texas to its Quebec City refinery in 2013[66]. For crude oil that uses the Enbridge pipeline system to get to Quebec City, a vessel move is required from Line 9's end point at Montreal. A smaller Panamax tanker vessel is required for this service due to route limitations; Valero presently has control of two such Panamax vessels for the operation.[67] In addition to the smaller vessel having less favorable economics as compared to larger vessels, this intra-Canada route requires Canadian-flagged

[61] PLG discussions with Canadian Ship Agents via Tanker Owners
[62] Hansa, *Euronav orders ice-class tankers* (October 2016)
[63] "Ice Class" refers to vessel variations with strengthened hulls that are able to withstand and penetrate ice floes in waters affected by such winter conditions.
[64] PLG analysis of vessels sailings to Valero Quebec terminal and Canada Energy Regulator, *Market Snapshot: Crude Oil Imports Declined in 2022, While the Share from the U.S. Increased* (August 2023)
[65] Current market price estimate for a 2-3 year time charter for this route
[66] Global Energy Report, *Valero to ship Texas crude to Quebec* (March 2013)
[67] Valero, *AN IMPORTANT PARTNERSHIP CREATING JOBS AND CONSOLIDATING QUEBEC'S ENERGY SUPPLY* (March 2014)

vessels under the Coasting Trade Act[68] and both factors increase the per-barrel cost[69]. PLG estimates a cost of $2.49/bbl to move crude from Montreal (end of Enbridge's Line 9) to Quebec City.

### *Optimal Vessel Classes for Calls at South Portland, ME Deliveries for Injection into Portland-Montreal Pipeline*

South Portland, ME is capable of taking Suezmax tankers with crude oil for discharge and furtherance to Suncor-Montreal via the Portland-Montreal Pipeline. However, in the case of US Gulf Coast supplies, even though the crude would be terminated and consumed in Canada, US Jones Act rules would still apply because the waterborne portion of the movement in this example takes place between two US ports. While a US flag vessel could potentially perform a voyage from the US Gulf to South Portland, the economics of the trade would have to be significantly advantageous to offset the higher cost of a US Flag vessel (on the order of three to four times the international freight rates) due to Jones Act regulations. Given the limited fleet size and that many US flag vessels have long-term employment contracts in place, the US flag is an unlikely option for marine movements to the Portland-Montreal Pipeline. Instead, South Portland would receive from the international waterborne crude market and there would be no difficulty in finding available vessel capacity for that service. South Portland, ME currently receives approximately one tanker per quarter "to keep the lines wet" for the Portland-Montreal Pipeline, the most recent voyage being an Aframax loaded in Algeria and discharged in South Portland. Previously during the period when South Portland was receiving significant volumes (before the latest Line 9 reversal in 2015) the terminal would receive 18 – 20 tankers per month (200 – 240 tankers per year). PLG estimates the cost to move a Suezmax from Northern Europe to South Portland, ME at $2.12/bbl and from Algeria to South Portland, ME at $2.52/bbl[70].

### *Crude Oil Types That May Be Supplied to Eastern Canadian Provinces in the Event of a Line 5 Shutdown*

Prior to the Enbridge Line 9 crude oil pipeline reversal in Canada that occurred in December of 2015, Canadian refineries in Ontario, Quebec, New Brunswick, and Newfoundland imported crude oil from a variety of source countries. Most notably, these Eastern Canadian provinces imported crude oil from OPEC members Saudi Arabia, Algeria, and Nigeria and much smaller volumes from non-OPEC countries such as Mexico, Norway, and the United Kingdom among others.

Beginning with the advent of the so-called "Shale Revolution" that occurred in the US Shale Oil-producing areas of the Eagle Ford, Bakken, Permian, and other basins, Eastern Canadian imports of US crude also began to materially increase. **As of 2022, US crude oil makes up the bulk of Canadian imports.** With resumption of waterborne deliveries as a primary delivery means for eastern Canada, US Gulf Coast supply mainly from the Permian Basin would be an efficient and economical source of crude for Line 78/5/9 refineries. In fact, since 2014 the US has been the primary source of imported crude oil for eastern

[68] A Canadian regulation similar to the US Jones Act; requires a Canadian-registered vessel that has been Canadian-built or duty-paid

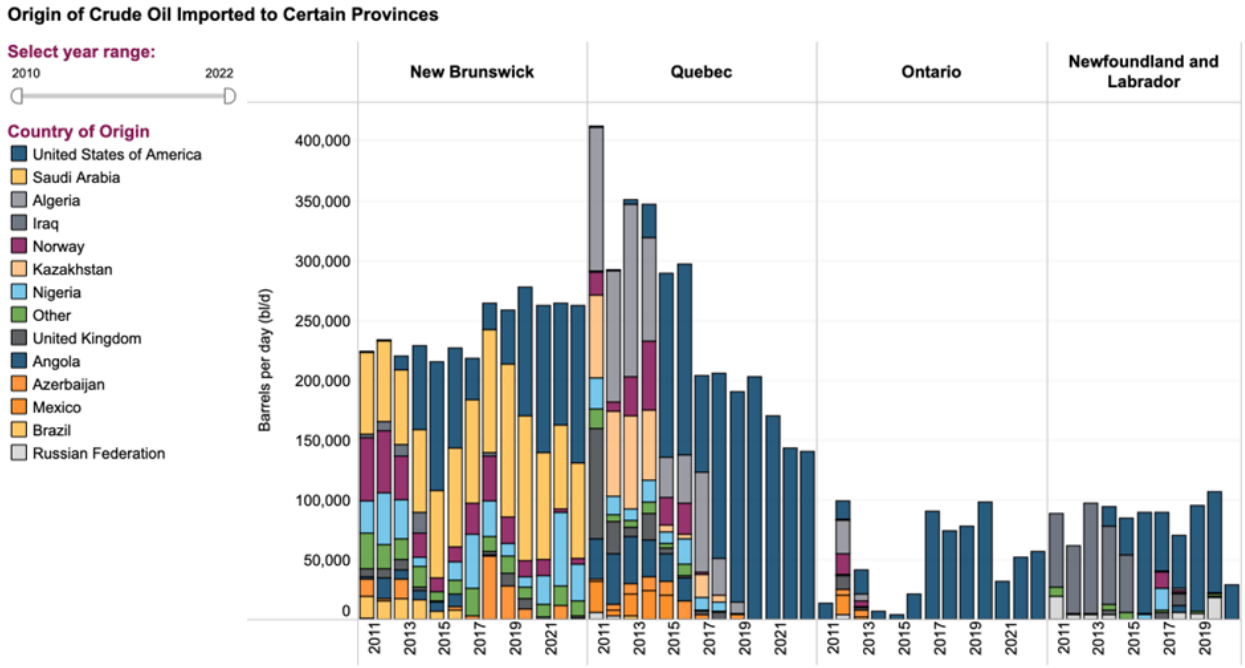
[69] PFCollins, *Importing a Vessel into Canada* (2022); Temporary use of other vessels is possible assuming no Canadian registered vessel is available or capable

[70] PLG estimate using current market price estimates for a 2-3 year time charter, includes vessel loading estimate but not discharging of vessel which is covered in Portland-Montreal tariffs

Canada, along with Algeria. Guyana is also rapidly expanding light sweet crude oil production and may be an additional potential source of crude oil for Eastern Canada.

## For nearly ten years, the US has been the primary source of imported crude oil for Canada.

**Figure 26: Canadian Province Crude Oil Imports by Country[71]**




In summary, delivery of waterborne crude to the Quebec refineries is a nearly immediate solution to provide an economical replacement for nearly half of the Line 5 contribution to the Enbridge system supply, requires no new capital spending, and is a method of transport that prior to 2015 was in fact the predominant source of oil for those refineries.

2. **Fully utilize the existing capacity of Line 78, which presently only operates at 78% of capacity – representing 128 kbpd[72] of new volume that may be delivered via that route.**

As noted earlier, Line 5's service into the ten refineries cited is actually the combination of Line 78 plus Line 5. In fact, Line 5's contribution represents a minority of pipeline-delivered crude to the region. Therefore, **operating Line 78 to its full capacity would be an obvious first step for the provision of replacement crude supply if Line 5 were to shut down.**

[71] Canada Energy Regulator, *Market Snapshot: Crude Oil Imports Declined in 2022, While the Share from the U.S. Increased* (August 2023)

[72] Expert Report of Sarah Emerson of ESAI (January 2022), PLG Analysis; Note: Line 78 has two sections (78A and 78B) and with different capacities and connections between each. See Figure 48.

Since Line 78 is also fed by the Enbridge Mainline, operating Line 78 to its full capacity begs the question of whether the Lakehead System lines (6, 14, 61) that feed Line 78 from Superior have themselves enough capacity to transport crude to Line 78's western starting point at Griffith, IN. There are two factors that affect whether the segment between Superior and Griffith can provide enough crude supply to fully load Line 78 at Griffith:

1) the priority under Enbridge apportionment[73] rules that Line 78/5 region refineries would have for the barrels coming from western Canada on the Lakehead system; and

2) current and future demand on that segment.

### *Priority of Line 78/5-Served Refineries Under Enbridge Apportionment Rules*

An initial question that could be prompted by utilizing Line 78 to its full capacity is whether the crude that would have previously been routed via Line 5 would have "priority" over other crude supplies routed via Lines 61, 6, and 14 to the Line 78 connection point at Griffith.

While Line 5 is fed from the Enbridge mainline system at Superior, WI, Line 78 is fed by the Mainline system via connecting lines (6/14/61) that run between Superior, WI and Line 78's origin point at Griffith, IN. Under Enbridge's apportionment policy that governs the allocation of oil in situations where downstream demand (at refineries and export ports) on the Lakehead system exceeds upstream supply, the refineries fed by Line 78 would be entitled to 769,700 bpd of oil – about 200,000 bpd more than the capacity of Line 78 and allowing Lines 6/14/61 and Line 78 to unquestionably be filled to capacity to serve the affected refineries[74].

**Figure 27: Enbridge Line 5, Associated Pipelines, Fractionators and Refineries[75]**


[73]Apportionment is the process of distributing available pipeline capacity among shippers when demand exceeds capacity, often to ensure fair access during constrained periods

[74] Expert report of Neil Earnest of Muse, Stancil & Co. (January 2022)

[75] Enbridge, PLG Analysis (September 2023)

*Current and Future Demand on the Enbridge Mainline and Lakehead Systems*

Taken together, lines 6, 14, and 61 represent approximately 2.2MM bpd[76] of capacity between Superior, WI and the Chicago area, which includes Line 78's origination point at Griffith, IN. Fortunately, those connecting lines are likely operating somewhat below capacity. With regard to current and future demand on those lines, a material market development is coming into play during fall of 2023: The Trans Mountain expansion project.

The Trans Mountain expansion adds an additional 590 kbpd (from current 300 kbpd) of export capacity for western Canada oil production to the west coast of Canada[77]. This project expands an existing pipeline between Alberta and an export terminal at Burnaby, British Columbia, enabling bluewater access and sufficient takeaway capacity to end persistent and often heavy discounting of western Canada crudes that has persisted for more than ten years.

Slated to commence operations by early 2024, this expansion is expected to decrease the demand for the Lakehead System going into the Chicago area where Line 78 begins[78]. This is because currently this section of the Lakehead System between Superior and the Chicago area is also used to move western Canada oil to the US Gulf Coast for exports. Since 80% (708 kbpd) of Trans Mountain's future 890 kbpd capacity is locked into 15- and 20- year committed contracts that require shippers to pay a penalty for not using that capacity, shippers can be expected to prioritize export barrels to the Canadian west coast instead of the US Gulf Coast. As such, Enbridge Mainline and Lakehead line capacity that would have otherwise moved barrels to the Chicago area for furtherance southward should be available as an additional assurance that Line 78 may be filled to capacity.

It should also be noted that Lines 6/14/61 are not the exclusive conduit of supply for Line 78. The Line 78 origin terminal at Griffith, IN is also connected to the larger mid-continent crude oil pipeline network, which provides access to the major pipeline and storage hub of Patoka, IL and access to supply from non-Western Canada sources, including the Bakken shale play.

### 3. Utilize existing crude-by-rail offload capacity at refineries with that capability today

When the newly-available barrels on Line 78/5 resulting from increased waterborne receipts in Quebec are then are added to the incremental additional barrels resulting from the full use of Line 78's capacity, **the shortfall of crude supply to the ten refineries in question decreases to just 90 kbpd**. In turn, that shortfall can be offset with rail deliveries to several of the affected refineries, starting with those facilities that already have the required infrastructure and a proven track record of receiving crude-by-rail. Selected examples of those refineries and related infrastructure are summarized below:

- Nanticoke, ON – Imperial has existing 20 kbpd of crude oil unloading capacity, with robust rail infrastructure as shown in Figure 28.

[76] Enbridge, *Enbridge's Energy Infrastructure Assets* (July 2023)
[77] RBN Energy, *Carefree Highway - Canadian Crude 'Re-Exports' From The USGC Surge On Pipeline Access, Overseas Demand* (September 2023)
[78] RBN Energy, *Carefree Highway - Canadian Crude 'Re-Exports' From The USGC Surge On Pipeline Access, Overseas Demand* (September 2023)

**Figure 28: Imperial Nanticoke, ON Rail Infrastructure[79]**

- Toledo, OH – This market has successfully utilized crude-by-rail via Midwest Terminal transloading and trucking services, delivering to PBF's truck unloading racks during the mid 2010s for a period of at least two years. The operation consisted of receiving unit trains at the Midwest Terminals Ironville facility from Norfolk Southern, transloading to trucks using portable transloaders, and delivering to the PBF Refinery. This solution is able to resume operations within three months, and has an estimated capacity of between 17-25 kbpd depending on whether PBF is able to dedicate two, three, or four truck receiving bays. PLG has investigated this option in detail and toured the Midwest Terminals, Port of Toledo, and other logistics infrastructure in the area within the past year.

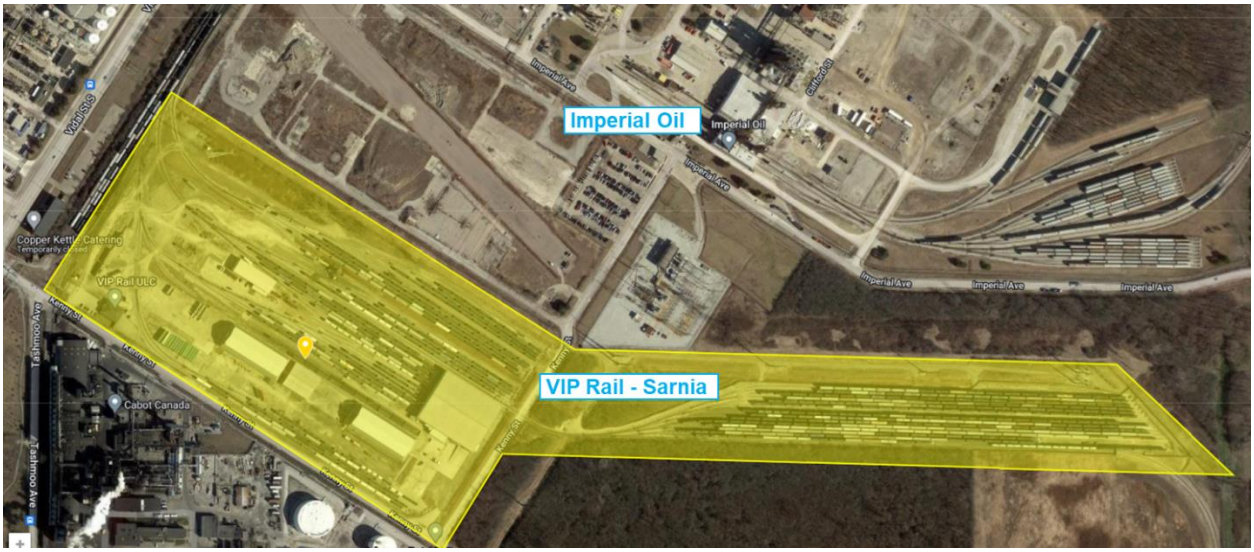
  Midwest Terminals' crude-by-rail services could also be used to provide delivery to Cenovus-Toledo. And, a complementary operation on the origin end would be Cenovus' crude-by-rail loading facility in Bruderheim, AB that has tank storage capacity of 240 k bbls, a loading capacity of 120 kbpd, and access to Cenovus' leased fleet of railcars. Cenovus has stated that this terminal "is part of the Company's strategy to create additional transportation options for our products and is designed to help us capture global prices for our crude oil production"[80].

- Sarnia and Corunna, ON – Due to its adjacency to Imperial-Sarnia and similar to Midwest Terminals, VIP Rail has and can provide crude-by-rail services and delivery to local refineries without requiring new capital investment at an equivalent volume of about 17 kbpd. VIP indeed provides this service today. VIP Rail also has another terminal nearby in Corunna that could also unload crude-by-rail to truck without new capital investment at the same estimated 17 kbpd rate.

It should be noted that while the total sum of estimated capacity for the above facilities and operations is approximately 79 kbpd, and crude-by-rail could begin at any one of these locations within three months, maximizing the full capacity of these crude-by-rail options could take additional time. This is to account for typical startup and transition efforts, including sourcing and assembly of railcar fleets, but initial volumes could begin to be handled right away. Therefore, PLG has taken a conservative approach in assuming that the initial commencement of crude-by-rail operations under Phase I would amount to approximately 37 kbpd within the initial three month Phase I window. This would represent utilizing the full 20 kbpd of fixed rail offload capacity at the Nanticoke refinery, and operating up to 17 kbpd of rail-to-truck shuttle transloading at either Midwest Terminals in Toledo, VIP-Sarnia, or VIP-Corunna.

[79] Google Earth (Retrieved September 2023)
[80] Cenovus, *2022 Annual Report* (February 2023)

**Figure 29: VIP Sarnia Facility**[81]




As an aside, Valero-Quebec City and Suncor-Montreal both have rail offloading capability. The identified Phase I solutions envision 100 percent of supply from waterborne deliveries, but the fact that these refineries can also receive crude-by-rail reflects the additional resiliency in the overall crude logistics ecosystem.

### Additional Resiliency in the System: Delivery of Refined Products to Eastern Canada and Northeast US Markets From Refineries Outside the Line 78/5 Area

The Phase I, II, and III solutions identified herein all assume the continued operation of each of the ten refineries within the Line 78/5 service area and thus make up 100% of the crude supply deficit that would be created by a potential Line 5 shutdown. While the Phase I, II and III solutions identified provide commercially viable and operationally feasible ways to more than meet that goal, as with the overall energy industry the refining business is dynamic and subject to changing investment decisions. And, of course, refining crude oil is not an end purpose, but rather the intermediate processing step needed to create the products consumed at the end of the supply chain: gasoline, jet fuel, diesel, and other refined products.

Therefore, **supply of refined products produced at refineries outside the Line 78/5 area is a viable solution that can fill interim or even permanent needs as part of a Line 5 shutdown transition.** In fact, **refined products already flow into the Line 78/5 area from non-Line 78/5-served refineries today.**

For the purpose of this analysis, the delivery of refined products to the Line 78/5 market area is considered a Phase I solution (meeting the definition of being able to be implemented virtually immediately and without major capital costs). And, it can be viewed as a highly flexible option to be used as an interim or long term solution under virtually any circumstance or market condition, i.e. to bridge gaps within Phase I, to offset crude-by-rail volumes, or in response to any refinery production curtailment that were to happen for any reason. This is not to imply that refined products are a one-for-one replacement of crude

[81] VIP Rail, Google Maps (Retrieved March 2022)

barrels to refineries; the market participants will determine the right balance of imported refined products and continued refinery runs in the Line 78/5 region, but certainly in the context of Phase I refined products imports is an important factor providing economical supply surety for a transition to a potential post-Line 5 future.

The refined products option is possible because **the flow of refined products within North America is as robust and diverse as the flow of crude and NGLs.** The refined products market in which Lines 78 and 5 serve can also have refined products delivered from Illinois, New Jersey, Texas, Oklahoma, or from waterborne imports from Canada and other points overseas[82]. As such, **supply of refined petroleum products in the Line 78/5 service area is assured whether or not any refinery in that area ceases operations for any reason, and whether or not Line 5 continues to operate.**

Refined products delivered from other regions would help offset any loss of refinery output in the Line 5 area.

Any supplement of refined products to the Line 78/5 area from external refineries would certainly meet the standard of operationally feasible and commercially viable. Enbridge's own experts have testified in recent litigation that there is available capacity on the refined-product pipelines that currently deliver products to the upper Midwest from the Gulf Coast, and thus that any price increase would be negligible—between half a cent and a cent per gallon of gasoline in Michigan and Ohio.[83]

To further illustrate the dynamism and constantly evolving nature of energy supply chain solutions as it relates to refined products: Canadian National Railway (CN) announced in its May 3, 2023, Investor Day marketing presentation[84] that there is a new fuel terminal opening in CN's MacMillan Yard to serve the greater Toronto area. According to the video presentation, fuel suppliers are accessing the waterborne global fuel surplus markets through eastern ports to bring in 450M to 600M US gallons (15K to 20K rail cars/year) of fuel per year into this new rail terminal. This equates to at least 30 kbpd of refined products via a new facility that joins other existing refined products terminals and supplies. CN also stated that they have excess capacity in their eastern network to meet this import demand.

It is worth noting that the new CN terminal is expected to target renewable fuel opportunities, which act as a one-for-one replacement of ethanol for regular gasoline, renewable diesel for conventional diesel, and sustainable aviation fuel (SAF) for conventional jet fuel. This investment supports Canada's Clean Fuel Regulations, which established targets to reduce greenhouse gas emissions from fuel sources to 15% below pre-2016 levels by 2030.[85] The compliance provisions of the Clean Fuels Act became effective in July, 2023.

As demonstrated in Figure 30, the symbiotic US-Canada relationship when it comes to energy continues to benefit both countries, as the US has become the primary supplier of refined products to Canada thanks to abundant feedstocks and refining capacity.

---

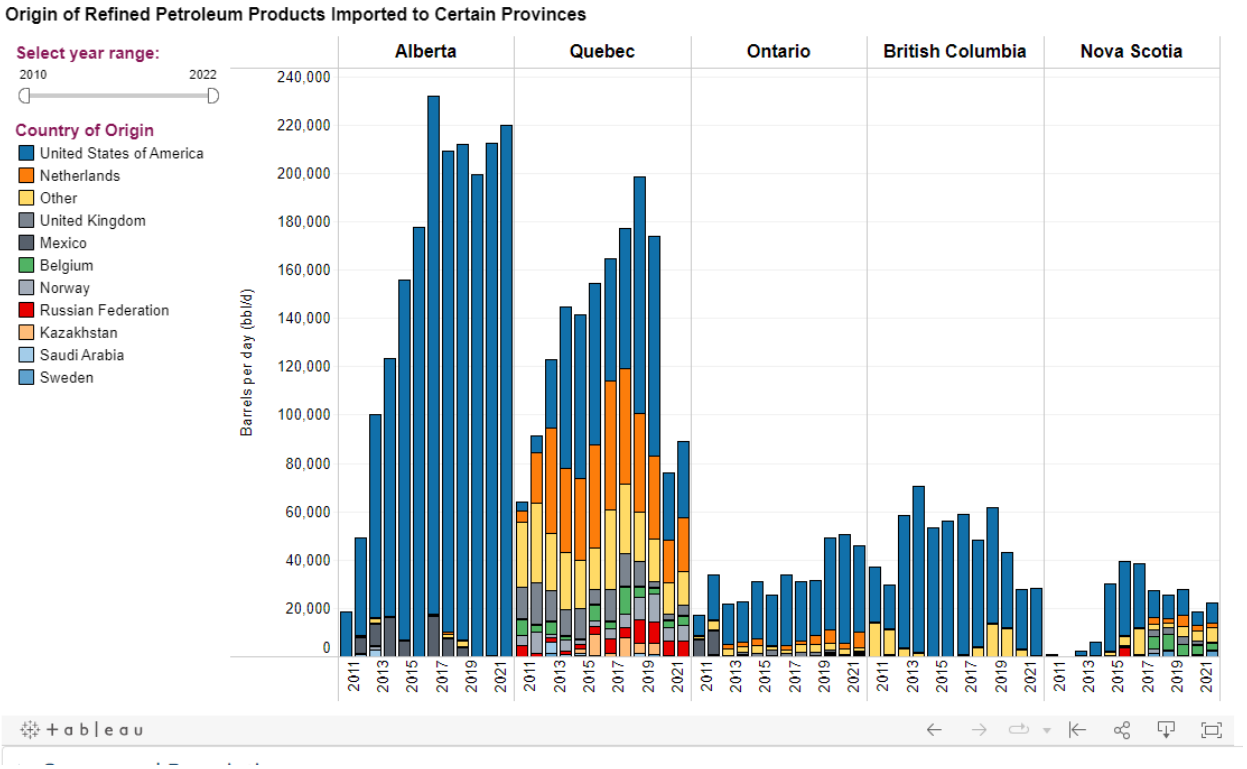
[82] Buckeye, Explorer and TEPPCO pipeline systems

[83] Expert report of Neil Earnest of Muse, Stancil & Co. (January 2022); See pages 72–73.

[84] RBN Energy, *Carefree Highway - Canadian Crude 'Re-Exports' From The USGC Surge On Pipeline Access, Overseas Demand* (September 2023)

[85] Government of Canada, *Examples of other clean fuel standards* (July 2022)

**Figure 30: Canada Imports of Refined Petroleum Products by Province[86]**




As another example, Michigan already relies heavily on and is well connected to refined products from other states. Supply sources include Chicago-area refineries as well as US Gulf Coast refineries (utilizing available capacity on Explorer Pipeline to get to the Midwest). There is an estimated 220 kbpd of available refined products pipeline capacity from the US Gulf Coast to the Chicago area[87].

Based on a tariffs filed by Sunoco, LP, there is pipeline transport from the Detroit area to Marysville, MI and from there across the Canadian border into Sarnia. The border crossing tariff between Marysville and Sarnia shows refined product shipment rates between the two locations.[88] Moreover, there is a tariff for the 13-inch Sun-Canadian[89] pipeline to receive refined products at Sarnia and move them into Ontario with terminus in Toronto. A velocity study for a 13-inch line indicates an expected upper limit of flow capacity of about 138 kbpd.

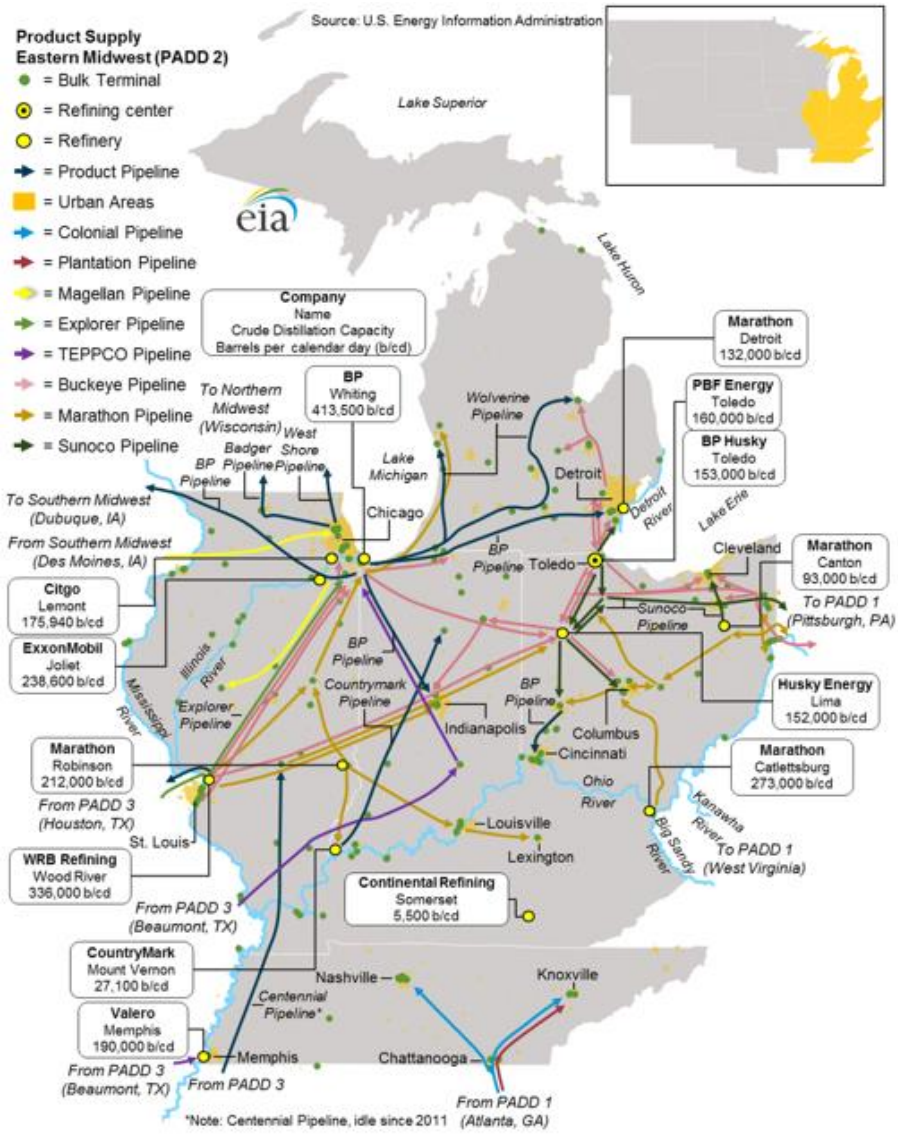
[86] Canada Energy Regulator, *Market Snapshot: Crude oil imports declined in 2021, while refined petroleum product imports rose modestly* (March 2022)

[87] 390 kbpd of product moved on 610 kbpd of capacity (390 kbpd from EIA 2022 PADD 3 to PADD 2 of distillate, gasoline and natural gasoline; Explorer lower capacity of 450 kbpd and TEPPCO capacity of 160 kbpd) (EIA, *Movement by Pipeline* (August 2023))

[88] National Energy Board, *N.E.B. Tariff No. 6* (May 2012); Sunoco Pipeline L.P., *Michigan Rate Sheet No.* 7 (July 2012)

[89] Offshore Technology, *Sun-Canadian System, Canada* (November 2021)

**Figure 31: Eastern Midwest Refined Petroleum Infrastructure**[90]



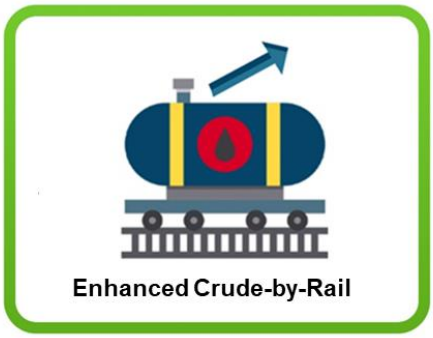

Notwithstanding the additional option of shipping increased refined products into the Line 78/5 market area, for the affected refineries the alternative crude oil supply sources and their associated logistics detailed previously in this report will enable continued economic viability of those refineries without a decline in refinery output. In turn, their ability to compete in the marketplace and provide a reasonable return for investors and continued employment of workers and staff will not be diminished in a future state wherein Line 5 is no longer operational.

### Phase II Near-Term (Within 18 Months) Alternative Supply Chain Solutions for Crude Oil

To reiterate, the Phase I solutions that can commence within three months and described above can replenish most of the crude shortfall created by a potential shutdown of Line 5, and without price spikes, supply shortages, or other adverse conditions. Those commercially viable and operationally feasible supply chain solutions can meet most of the market need, especially with the added contingency factor of refined products imports. However, although not needed to make up for any significant shortfall, other additional steps and solutions can be exercised if market opportunities warrant adding more optionality and efficiency in the Line 78/5 region.

[90] EIA, *Midwest and Rocky Mountain Transportation Fuels Markets* (March 2017)

Crude-by-rail makes up a small but important component of the Phase I solutions, and in forms that already exist and operate today or within the recent past – with fixed racks at Nanticoke, ON and transloading and truck shuttle operations at Sarnia, ON and Toledo, OH. As part of a post-Line 5 future state, enhancements to those operations may be of interest to certain refineries and market players. Such enhancements may involve additional infrastructure – whether tanks, track, piping, and unloading racks – all of which can be installed and operational well within 18 months, and likely much more quickly. The benefits of such investment would be to enable larger volumes and also lower per-barrel costs for crude-by-rail operations. Following implementation of Phase I solutions and unless and until Phase III solutions that would expand pipeline capacity (see below) are pursued, enhanced crude-by-rail is the most logical solution to supplement the flow of crude to the Line 78/5 service area. For these reasons, **enhanced crude-by-rail capability is the primary Phase II solution identified by PLG.**




In reviewing the ten refineries within the Line 78/5 service area and their respective locations, the most obvious locations for enhanced crude-by-rail operations are in Sarnia and Toledo (although it again bears mentioning that all of the affected refineries outside of Quebec would continue to be delivered crude primarily by pipeline from Line 78). Fortunately, available rail-served industrial property, existing rail terminal infrastructure, and highly reputable and experienced service providers conjoin refineries in both markets. Each of the service providers described below have successfully and economically handled significant volumes of crude-by-rail using portable transloaders and short-haul truck shuttle moves, with some operations currently running today as described in the Phase I crude-by-rail discussion. **All of the firms cited have the facilities and interest in expanding to fixed offloading infrastructure in response to new business opportunities.**

In addition, because adjacent properties and terminals are already zoned and in use for industrial purposes, **the amount of investment required to enhance the crude-by-rail services and infrastructure are well below historical investment amounts** associated with the build-out of crude-by-rail terminals that took place during the prior decade. Those prior investments were often on undeveloped or "greenfield" land and not taking advantage of existing property and terminals, and often those investments were made to create capacity far exceeding what is needed to enhance crude-by-rail operations at Sarnia and Toledo in order to make up the small remaining deficit created by a potential Line 5 shutdown.

### *Economics of Crude-By-Rail Facilities*

Based on PLG's experience and publicly available information regarding even larger crude-by-rail facilities in North America[91], **enhanced crude-by-rail capability can be installed at Sarnia or Toledo at a cost range of approximately $15MM-$35MM[92] and completed within 18 months.** The wide variance in estimated capital costs is dependent on how much additional track may be installed, number of unloading racks, size

[91] PLG analysis of 20 selected US crude-by-rail terminals built since 2012

[92] Based on conceptual engineering designs and equipment specifications; cost will vary depending on length of new track installed, number of offloading racks, length of piping, and size of tanks.

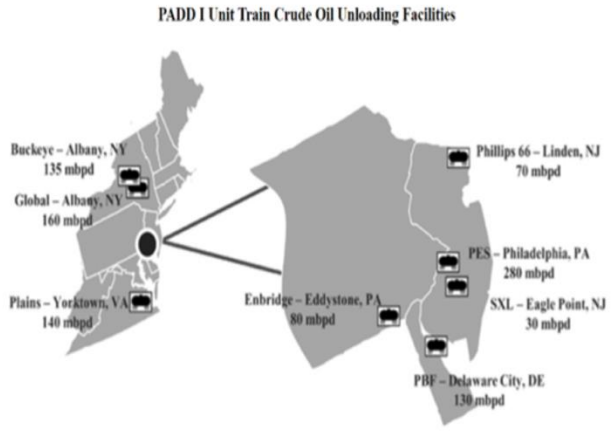
and number of tanks, length of piping, and other variables. And, as mentioned earlier, all of the candidate locations for enhancement of facilities are already industrial sites with existing rail (and in some cases pipeline) infrastructure, providing a "head start" to any development in terms of cost and timing.

Part of the reason that the crude-by-rail enhancements at Sarnia and Toledo require only a modest capital investment and can be accomplished expeditiously is because the service provider firms occupy land already under their control, such that improvements to handle additional crude-by-rail constitute modest expansions of existing rail and industrial property as opposed to new or "greenfield" developments. By comparison, the industry developed dozens of even larger new terminals to accommodate the implementation of crude-by-rail during the 2010s. Nearly all were built in less than 18 months, and these were much larger facilities than the enhancement projects that would be driven by the small percentage of Line 5 volumes that would need to shift to crude-by-rail in the event of a Line 5 shutdown.

To illustrate, the crude-by-rail receiving terminal built in 2013 for the former Philadelphia Energy Solutions refinery is a good example of an offloading facility project that was successfully permitted and built despite proximity to neighborhoods, two interstate highways, and the Philadelphia sports complexes. The project took only 15 months from announcement to opening of the rail unloading facility. Enbridge itself took less than 16 months from announcement to completion of a rail and truck transload center supporting three unit trains per day in Berthold, ND. And those projects were far more complicated than the rail investments that would be made in Sarnia and Toledo.

As stated earlier, any additional rail unloading capacity at Sarnia or Toledo would come from expanding an existing terminal or constructing it on a "brownfield" rather than "greenfield" site. Sarnia, Ontario is a highly industrialized area and has many chemical plants and oil refineries. There have been many unit train crude oil unloading terminals built in eastern North America (Figure 32), and in much more populated areas with likely similar permitting/environmental issues as the Line 5 destination market area.

**Figure 32: East Coast Crude-by-rail Unloading Facilities[93]**




And, for the purpose of providing replacement volumes due to a Line 5 shutdown, after the Phase I initiatives of increasing waterborne imports and fully utilizing Line 78, the remaining shortfall to be addressed by crude-by-rail is 90 kbpd. If the Phase I crude-by-rail initiatives identified earlier and conservatively estimated at 37 kbpd are implemented using existing facilities and operations, that shortfall is reduced to 53 kbpd. As such, when contemplating fixed infrastructure enhancements to improve efficiency and throughput via crude-by-rail, it would be sufficient to make fixed crude-by-rail enhancements at just one of the candidate sites mentioned below (although market conditions could certainly materialize that might cause the development of more than one crude-by-rail facility enhancement).

[93] Philadelphia Energy Solutions, *Form S-1* (February 2015)

**The capitalization and funding mechanisms for crude-by-rail terminals are quite straightforward**, and usually involve a "take or pay" minimum volume throughput customer commitment. In fact, virtually all of the crude-by-rail terminals built in North America have been developed with an initial customer commitment, which is typical of major logistics infrastructure investments (including pipelines). Once a take-or-pay commitment is contracted, the service provider is able to fund construction of the project using a variety of financing options, including debt, balance sheet, or in some cases capital participation by the customer.

The take-or-pay commitment requires a contractual obligation of the customer to ship a minimum volume of throughput and for a minimum number of years through the facility, whether or not that minimum throughput is actually achieved. A rate will be set for that throughput on a per barrel basis, which can typically range from $1.50 - $3 /bbl. for the facility to provide receipt and handling of a unit train or blocks of cars, offload of product, and return of the train or cars to the serving railroad. If the facility is also providing storage in tanks, there can be additional charges for their use.

Under these usual and customary terms within the industry, the shortfall volume cited above of 53 kbpd and the high-level capex projection for the candidate crude-by-rail expansion sites can be applied to the following hypothetical take-or-pay agreement:

**Figure 33: Hypothetical Enhanced Crude-by-Rail Facility Capitalization and Terms[94]**

| |
|---|
| Customer throughput commitment: 53 kbpd for three years |
| Transload (throughput) fee charged: $2.00/bbl |
| Equivalent annual revenue: $38,690,000 |
| Annual operating cost: $6,000,000 |
| Free cash flow: $32,690,000 |
| Investment capex with interest: $39,483,820 |
| Payback period: Approximately 1.2 years. |

Each of the inputs in this example can be considered individual "dials" that shippers and service providers will adjust based on the specific needs of the counterparties and the project. For example, the volume, length of commitment, rate, and other terms can be negotiated to achieve a mutually satisfactory deal. While there can be numerous variables that will affect specific projects and sites, the above economic structure is the general approach that has been used for not just crude-by-rail facilities, but most terminals involving the handling of bulk commodities.

## With "take-or-pay" commitments, crude-by-rail terminals typically pay for themselves within five years.

[94] Based on PLG analysis of existing crude-by-rail operations; existing facilities such as those at Sarnia and Toledo may have more advantaged economics due to the ability for the existing workforce capacity to add new business. Investment capex with interest assumes $35MM capex at 8% interest amortized over three years.

The characteristics of this kind of investment are highly attractive to both operating companies providing bulk terminal services, and also infrastructure-oriented investors who have flocked to rail logistics companies in recent years as hard assets with predicable cash flows.[95] The generally quick payback period for these investments also explain why, as crude-by-rail peaked and then declined in the mid to late 2010s, the numerous crude-by-rail terminals that were built during that time did not trigger widespread losses or bankruptcies among investors, because even if a facility dramatically reduced volumes over time, the initial throughput commitments that underwrote the development of those facilities provide a full return on investment from the asset within a short period of time.

What follows is a discussion of specific candidate site locations for enhanced crude-by-rail facilities and the respective operating companies presently serving the Sarnia and Toledo markets today with bulk commodity rail transloading and handling, including crude and NGLs. Two of those three operating companies are backed by large infrastructure funds. **All three have expressed to PLG an interest in supporting additional rail and transloading activity that may be necessitated by a potential Line 5 shutdown.**

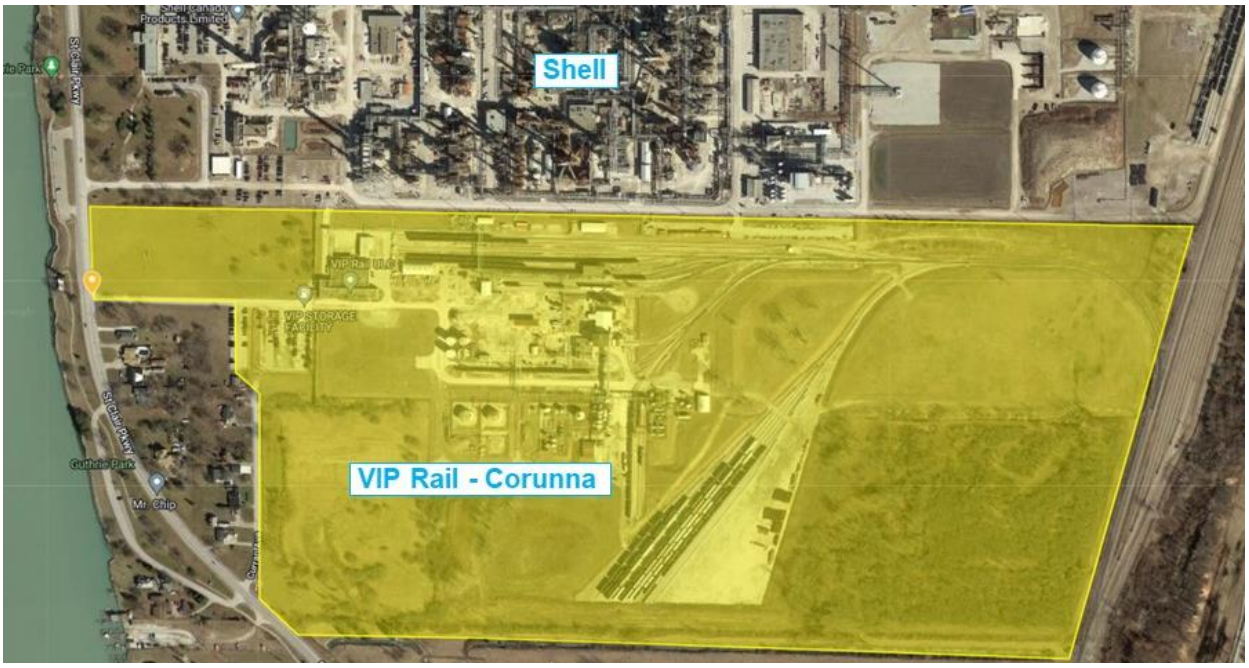
### *Crude-by-Rail Enhancement Options at Sarnia*

As discussed earlier, an example of a site with existing crude-by-rail receipt capability and potential for infrastructure expansion is the VIP Sarnia facility[96] (along with its significant amount of rail track). VIP Rail is a well-respected service provider with equipment, facilities, and a proven track record in handling crude-by-rail receipts for local refineries. Although today the crude-by-rail operations here involve transloading and a short truck shuttle move, this facility and Imperial Oil share a property line (Figure 29). As such, an above-ground "over the fence" pipeline can be constructed using existing pipe racks and without underground permitting to enable even more efficient transfer of crude unloaded from trains to be delivered to the refinery.

VIP also has a facility in Corunna that shares a property line with the Shell refinery, also making it likely that a short pipeline could be built relatively easily to connect the two facilities (Figure 34). VIP Corunna has 160 acres of heavy industrial zoned land on the east side of its property that it is advertising to develop[97]. This land could likely be used to add additional track to handle more railcars, tankage, and offloading infrastructure.

[95] Infrastructure Investor, *US rail investment reaches a junction* (October 2023)
[96] VIP Rail, *Land Available* (Retried September 2023 from VIP Rail website)
[97] VIP Rail, *Land Available* (Retried September 2023 from VIP Rail website)

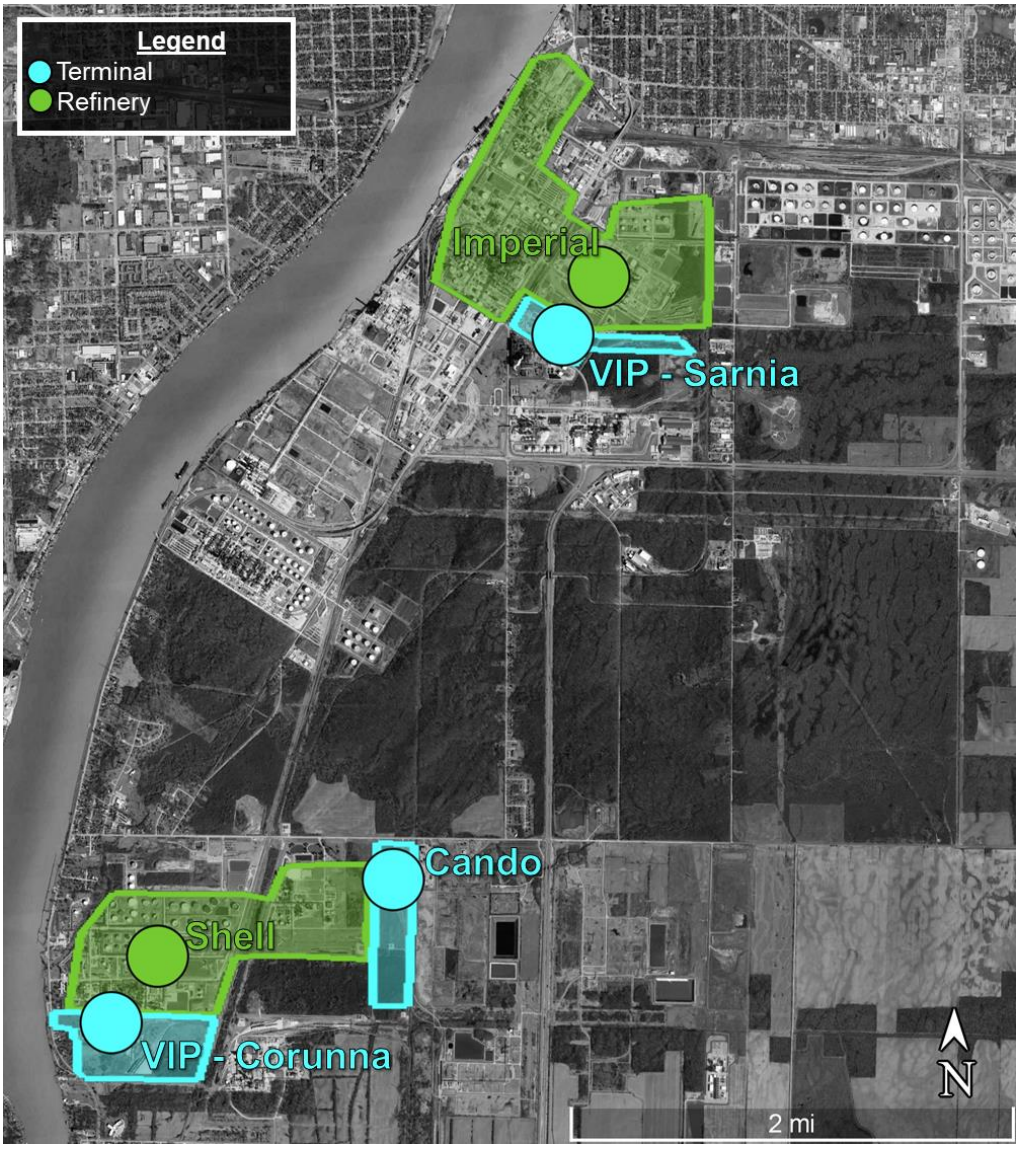
**Figure 34: VIP Corunna Facility**[98]




The Cando Rail & Terminals Ltd. Sarnia Terminal located proximal to Pembina (and adjacent to the chemical portion of the Shell refinery and chemical complex, and along the St. Clair industrial spur over which Cando operates) recently completed an expansion that increases railcar capacity from 85 spots to approximately 550 spots. Cando Sarnia Terminal is located on approximately 90 acres in the Sarnia Chemical Valley region and is directly serviced by CN off the CN St. Clair industrial spur. The multi-purpose Sarnia Terminal offers services seven days per week for railcar staging for short or long-term, loaded or empty railcars, as well as transloading numerous products to or from railcars. The terminal also has a two-track railcar repair shop and two-track railcar wash facility.[99] This terminal is already capable of handling unit trains, and has plans for further expansion to 800 railcar spots.

[98] VIP Rail, Google Maps (Retrieved March 2022)
[99] Cando Rail & Terminals, *Cando Expands Its Sarnia Terminal* (June 2023)

**Figure 35: Sarnia Refineries with Next-Door Third-Party Rail Terminals[100]**




*Crude-by-rail Enhancement Options at Toledo*

In Toledo, Midwest Terminals' Facility 1 has 23,000' of track with CSX rail service that is also open to CN, NS, and Ann Arbor Railroad. Like VIP and Cando, Midwest Terminals is a well-regarded service provider with a proven track record of handling crude, refined products, and other energy commodities.

[100] Google Earth, PLG Analysis (September 2023)

**Figure 36: Midwest Terminals' Facility 1 and Cenovus Toledo Refinery[101]**

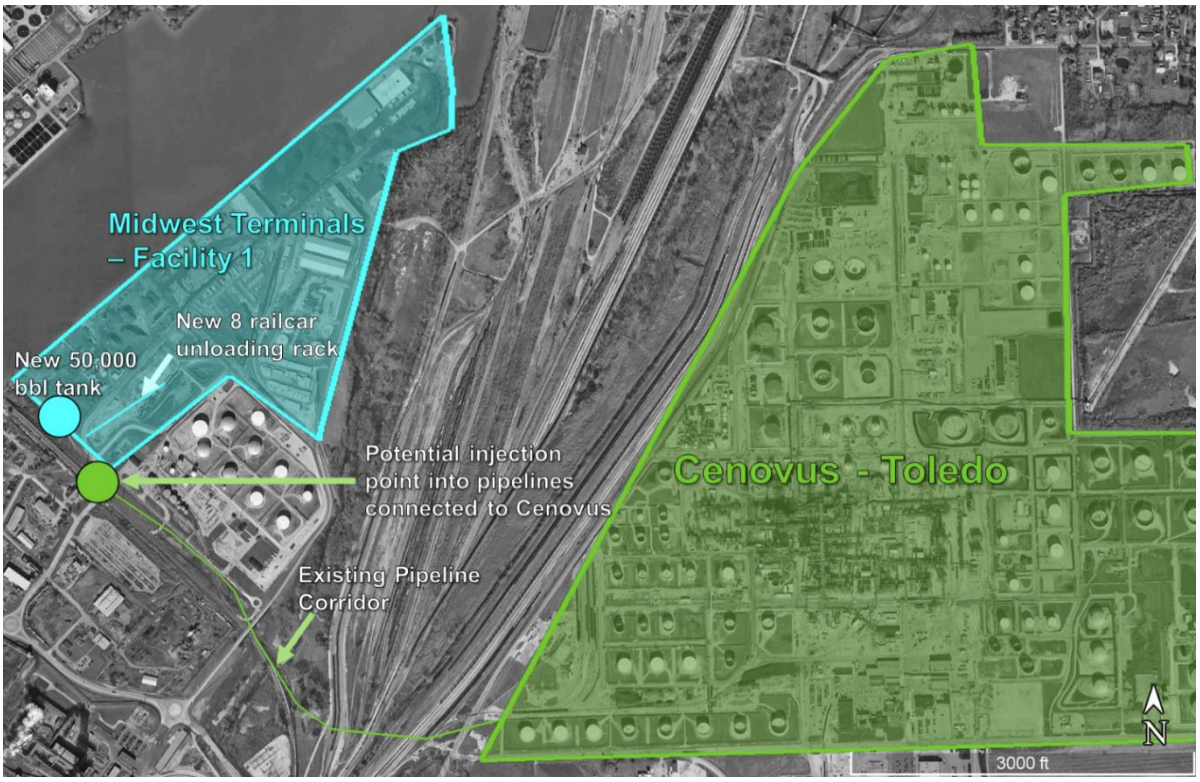
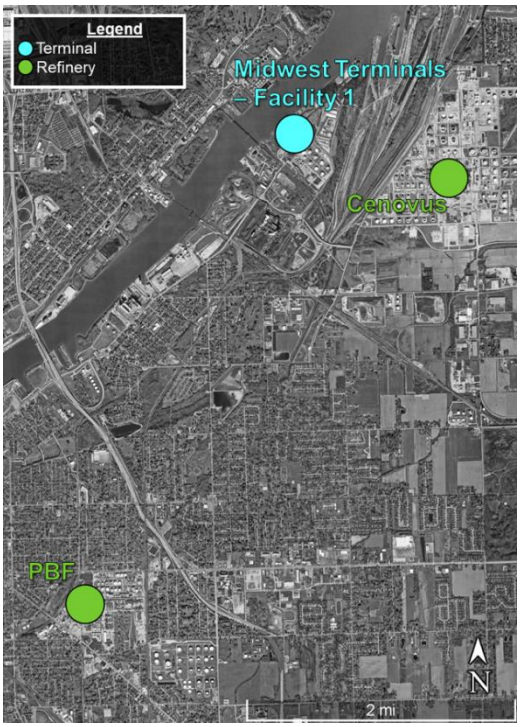



**Figure 37: Midwest Terminals – Facility 1 and Toledo Refineries[102]**

Midwest Terminal's Facility 1 in Toledo is capable of bringing in crude oil and injecting it into an existing pipeline that connects to Cenovus's Toledo refinery with minimal infrastructure investment. As seen in Figure 36, Facility 1 has a recently built 50,000 bbl tank along with eight new railcar unloading racks that will be operational by the end of 2023. And, with minimal infrastructure investment this location could provide a rail-to-pipeline solution by building a short connection to an injection point in an existing pipeline corridor of multiple pipelines that connects to the Cenovus refinery. Additional unloading racks could also be installed in order to allow for efficient unloading of crude oil unit trains. PLG has been able to tour the Midwest Terminals facilities, including investments being made to handle additional energy-related business.



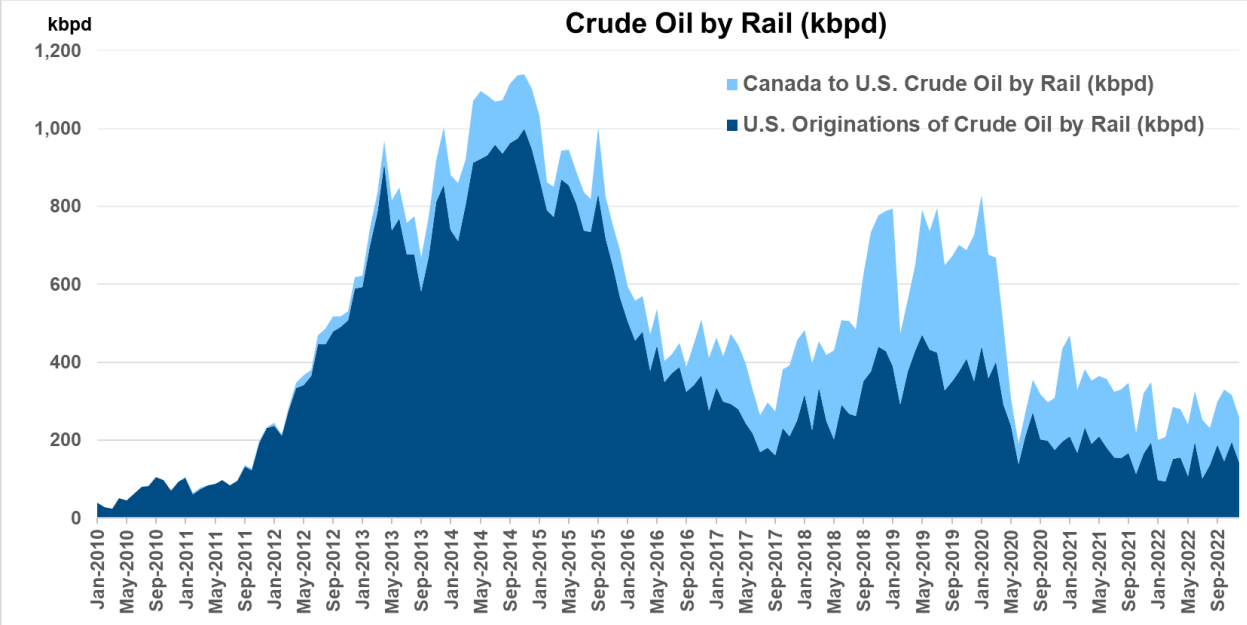

[101] Google Earth, Midwest Terminals, PLG Analysis (September 2023)
[102] Google Earth, Midwest Terminals, PLG Analysis (September 2023)

*In Context: Crude-by-rail Volumes Resulting From a Potential Line 5 Shutdown Relative to Overall Crude-by-rail Activity in North America*

Crude-by-rail in North America is a well-established business that has played an essential role in the transport of crude oil since around 2011, when large scale use of that service was implemented to improve market reach between emerging shale plays and refining centers. The crude-by-rail "ecosystem" consists of rail carriers, both origin and destination terminals, tank car builders and lessors, and several other categories of service providers. This ecosystem has been elastic, growing and contracting as overall demand has changed due to a variety of factors. As such, the implementation of crude-by-rail operations is a straightforward process with an experienced vendor base and operating under a clear and effective regulatory framework.

Crude-by-rail volumes are today much smaller than those of about ten years ago. As such, there exists ample capacity in facilities and rail linehaul services to handle the small portion of Line 5 volumes that would be routed via rail transportation solutions in the event of a shutdown. **Within the context of historical volumes, new crude-by-rail demand created as part of alternatives to Line 5 (which are estimated to be between 37-90 kbpd) would be quite small.**

**Figure 38: U.S. and Canada Originations of Crude Oil by Rail[103]**




As illustrated in Figure 38, crude-by-rail (including intra-U.S. movements and U.S. imports from Canada) has seen a large decrease since its peak, when 1,139 kbpd were transported by rail in November 2014 as compared to just 218 kbpd in May 2023, a decrease of 81%.[104] The Phase I and II recommendations for crude-by-rail activity described above, which amount to 37 kbpd and 90 kbpd, respectively, represents just 3% and 8% of the total historical peak crude-by-rail activity (2014) and 4% and 11% of the more recent historical peak (2018-2019) in North America.

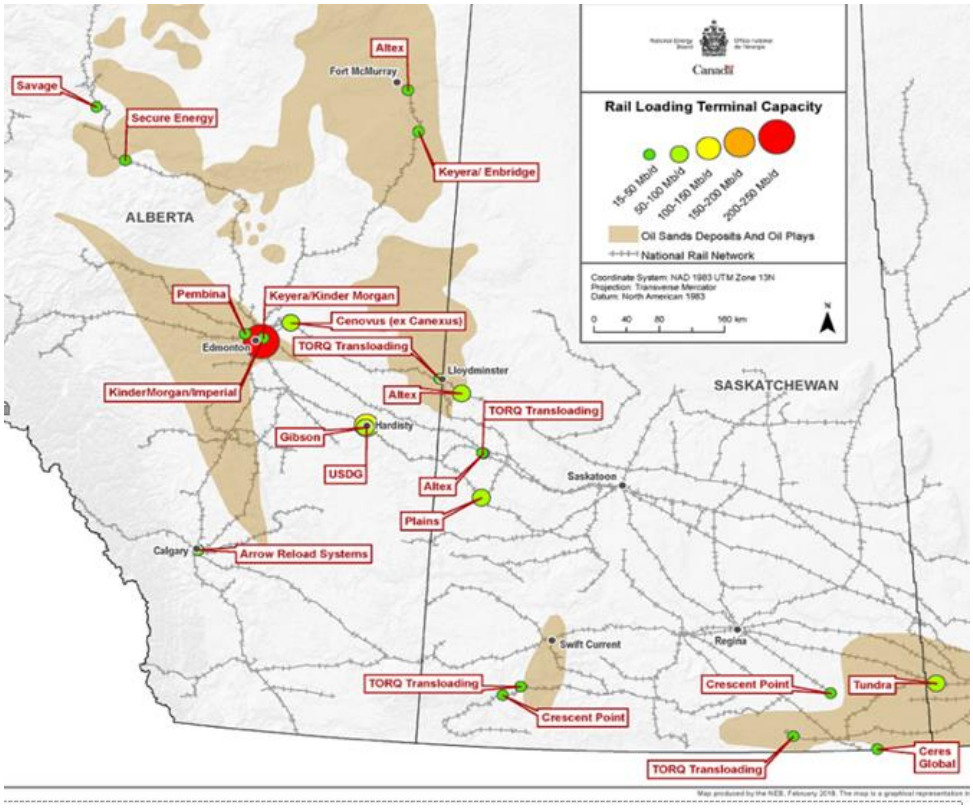
[103] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023)
[104] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023)

The obvious implication of current crude-by-rail demand relative to the recent past is that there exists significant excess capacity in the overall crude-by-rail transportation "ecosystem" to absorb the comparatively small volumes of crude-by-rail that would be created by a Line 5 shutdown and under the Phase I and II solutions described above. That ecosystem includes: origin rail loading facilities in Western Canada, the Bakken shale play, and elsewhere; the supply of tank cars suitable for crude oil that are not only provided by railcar builders and lessors but also controlled in significant volumes by the actual market players already involved in Line 5 products and markets; and the linehaul transportation capacity of individual rail carriers and routes that would provide the service.

> Crude-by-rail activity created by a potential Line 5 shutdown would amount to just 3-8% of historical peak volumes.

### *Crude-by-Rail Loading Capacity*

**Figure 39: Western Canada Crude-by-rail Loading Terminals[105]**

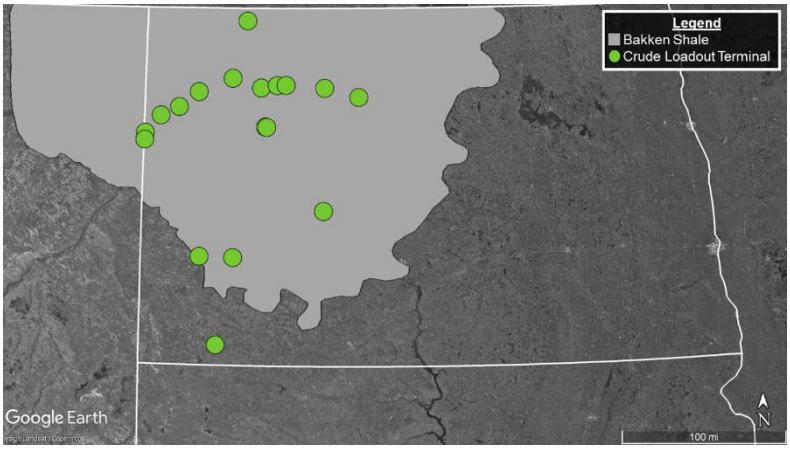



From an origin terminals standpoint, there exists ample capacity for new crude-by-rail carloads. Starting in Western Canada, there is significant underutilized rail loading capacity not just in Edmonton but also throughout Alberta as illustrated in Figure 39. In 2018, there were approximately 1.2 million barrels per day of crude rail loading capacity in Western Canada. There have been expansions since 2018, including U.S. Development Group's Hardisty, Alberta terminal expanding to a capacity of ~270 kbpd. Imperial's Edmonton Rail Terminal (through joint venture with Pembina) has capacity to ship 210 kbpd of crude oil by rail.[106] As discussed earlier, these terminals have historically seen much higher volume throughput

[105] Canada Energy Regulator, *Major crude oil rail loading terminals in the WCSB* (February 2018)
[106] Imperial Oil, *Edmonton rail terminal* (Retrieved September 2023)

than would be required by a hypothetical additional loadout requirement generated by a Line 5 shutdown. And again, this even assumes that all of the replacement volume to be handled by rail would need to still come from western Canada, which it would not.

**Figure 40: Bakken Crude Oil Rail Loadout Terminals[107]**




The excess capacity in the crude-by-rail system is reflected in the number of crude-by-rail terminals in both Canada and the US that are available for rail-loadout. The Bakken shale play is another potential source for loading crude-by-rail in the event that current Line 5 refiners choose to be supplied by that product. The Bakken has a large amount of crude-by-rail loading capacity that is presently underutilized. Bakken rail loading capacity is 1,230,000 bbls/day, while actual rail loadings were only 141,000 bbls/day for June 2023 (latest month available)[108] - equating to 89% available capacity.

### *Tank Car Supply for Phase I and II Crude-by-rail Operations*

Crude-by-Rail is approved (based on mechanical specifications) in a specific tank car type designated as DOT-117. This model of tank car, which can consist of either new or retrofitted cars, features enhanced sturdiness and safety features and through regulations encompassed in the FAST Act of 2015 has become the required car for both crude oil and ethanol.[109] There are currently about 92,000 DOT-117 tank cars operating in the North American rail network (Figure 41).

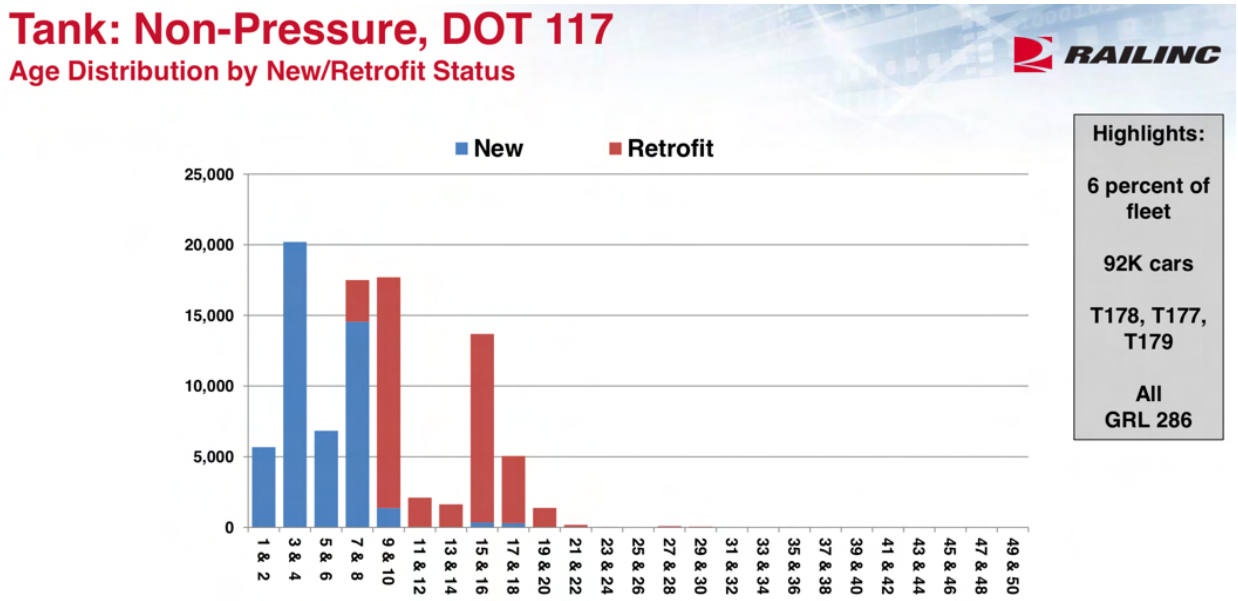
Because it is the most modern standard of tank car specification, the fleet of DOT-117 tank cars is relatively "young" with an average age of 7.5 years.[110] And, this fleet experienced a surge of production within the last eight years to accommodate, in part, the most recent increase in crude-by-rail activity in 2019. As crude-by-rail volumes have decreased since that time (Figure 38), demand for DOT-117 cars for that service has declined but has increased for use in ethanol service due to regulatory factors.

For this reason, the initial volume called for under Phase I crude-by-rail activity has been conservatively projected at 37 kbpd to account for reassignment and deployment of DOT-117 tank cars for that service. It is reasonable to expect that existing fleet would be more than adequate to handle this initial volume and as such the ability to implement Phase I crude-by-rail operations would not be constrained by tank car supply. Put into context, even if *twice* that volume were the initial demand for crude-by-rail service due to a Line 5 shutdown, and it were to be assumed that all of the supply would still need to come from

[107] EIA (October 2020)
[108] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023); From PADD 2 to U.S. for Crude Oil
[109] Railway Supply Institute, *Tank Car Resource Center* (Retrieved September 2023)
[110] Railinc's Umler system, PLG Analysis (October 2023)

the farthest production area (Western Canada) and be delivered to Sarnia, the total fleet requirement for such an operation would be approximately 2,350 tank cars, or about 2.6% of the DOT-117 fleet.[111]

**Figure 41: North American DOT-117 Tank Car Fleet[112]**

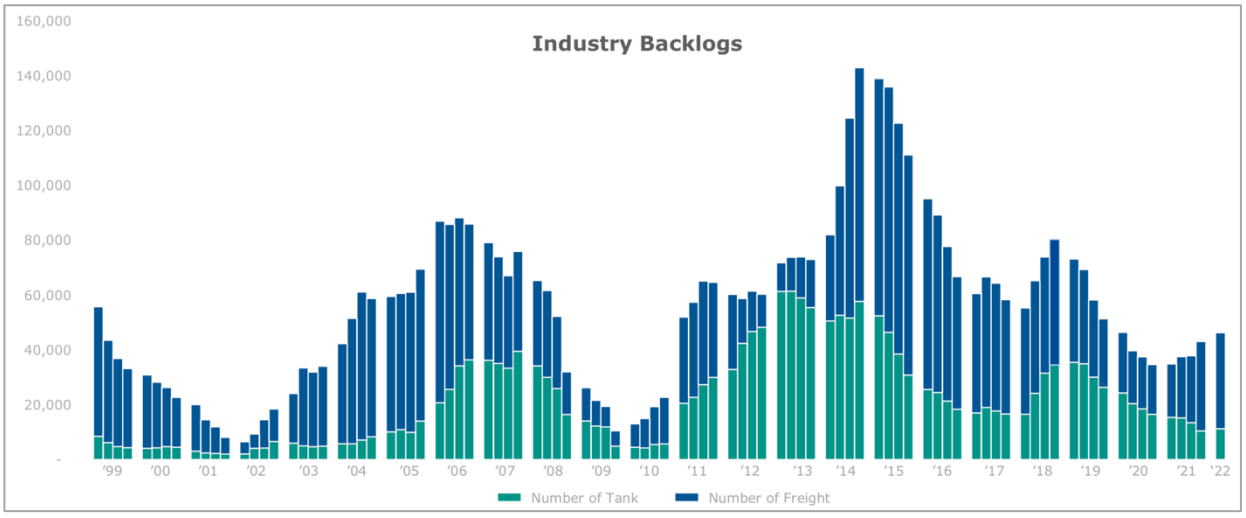



For startup of any new rail service requiring tank cars, it is critical to recognize *how* fleets are assembled for new operations. It is also important to note that **all of the existing market players involved in Line 5 markets and products are large and sophisticated refiners and midstream operators**, including ExxonMobil/Imperial, Shell, Plains, Valero, Pembina, Suncor, Marathon, and others. All of those companies already have large tank car fleets under their own control either through ownership or lease, and as such have significant leverage and buying power with tank car lessors and builders.

Therefore, any new requirement to add railcars for Line 5 alternative supply chain solutions would not involve unknown shippers having to cold-call for railcars. Rather, the market participants will be able to first examine their own large existing fleets to identify equipment that can be utilized in the new service. If necessary, as a second step these players will go to the well-known vendor base of railcar builders and lessors, with whom these established market players have longstanding relationships and negotiating leverage. And, with regard to railcar builder order books and build queue, the current railcar order backlog across all types of railcars as of July 2023 was 59,878[113]. Other than during the 2020-2021 pandemic years, the current backlog is relatively low as compared to recent industry peaks (Figure 42). As a result, if new tank car orders are warranted to support the eventual implementation of Phase II enhanced crude-by-rail operations (an additional 53 kbpd), the current manufacturing backlog would allow for delivery of new cars within an 18 month period to allow for the startup of Phase II operations by that time.

[111] Based on PLG fleet sizing model for 70 kbpd via rail, 19 day cycle time, 1,994 rail miles via CN-direct unit train service, and 15% contingency factor for weather, bunching, bad orders, and other delays.
[112] Railinc (March 2023)
[113] Railway Supply Institute, *Railcar Orders, Deliveries & Backlog* (July 2023)

**Figure 42: Historical Railcar Order Backlog[114]**




In summary, the combination of

- existing market players having significant tank car fleets of their own already,
- plus their strong commercial position with railcar builders and lessors,
- plus the relatively small fleet size required to provide crude-by-rail as an alternative solution for Line 5 replacement volumes after other Phase I solutions are implemented,

means that **tank car supply will not be an impediment to use of crude-by-rail as an alternative supply chain solution for Line 5 crude markets** in combination with the other Phase I initiatives identified. This is particularly the case if crude-by-rail operations were to ramp up gradually with just the initial volume of 37 kbpd being handled (requiring about 1,242[115] cars if Alberta remained the origin); even if new cars were ordered by market participants for this service they would be able to be delivered within an 18 month sufficiency window for Phase II based on current railcar builder order books.

Tank car supply will not be an impediment to use of crude-by-rail as one of several alternative supply chain options for Line 5 crude markets.

### Phase I and II Economic Analysis

In evaluating a post-Line 5 future state, it is possible to analyze what might be expected to be the new total landed cost for crude oil in the affected region. To answer that question, there are several factors to consider as the supply chain is reorganized and not just logistics, but also origin sources of crude, are evaluated.

[114] GATX (July 2022)

[115] PLG fleet sizing model under same assumptions for cycle time, route, type of service, and contingency

**Figure 43: Current Estimated Delivered Crude Costs**[116]

| Crude Supply Chain | Crude Volume (kpbd) | Logistics Costs ($/bbl) | Crude Price Before Logistics ($/bbl) | Delivered Cost Estimate ($/bbl) |
|---|---|---|---|---|
| Line 78/5 to Sarnia, ON | 253 | $4.68 | $79.53 | $84.21 |
| Line 78/5 to Nanticoke, ON | 95 | $5.00 | $79.53 | $84.53 |
| Line 78/5 to Montreal, PQ | 125 | $8.24 | $79.53 | $87.77 |
| Line 78/5 to Montreal, PQ, then water to Quebec City, PQ | 76 | $10.73 | $79.53 | $90.26 |
| Line 78/5 to Toledo, OH | 166 | $5.71 | $79.53 | $85.24 |
| Line 78/5 to Detroit, MI | 82 | $6.54 | $79.53 | $86.07 |
| Line 78/5 to Warren, PA | 64 | $4.91 | $79.53 | $84.44 |
| USGC Waterborne to Quebec City | 107 | $2.80 | $84.75 | $87.55 |
| Other Crude Oil Pipelines | 165 | $2.98 | $82.53 | $85.51 |
| **Total- 1,133** | | | Weighted Average- | **$85.84** |

As a starting point, Figure 43 provides current estimates for landed cost of crude at each of the refineries, along with a weighted average across all ten. The current weighted average of landed costs for refineries within the Line 78/5 region, and across the total volume from all modes, is **$85.84/bbl.**

By comparison, under the full 18 month Line 5 shutdown scenario whereby Phase I and II solutions are fully enacted, the total weighted average landed cost across all ten Line 5-related refineries and their crude oil supply has an estimated weighted average of **$86.52/bbl**, an increase of **$0.68/bbl.**

[116] PLG analysis, Enbridge pipeline tariffs, CME and ICE 9/15/2023 July 2024 crude futures, Alberta Energy Regulator forecast for WTI-CLS, WTI, CME WTI Houston (Argus) vs. Brent July 2024 futures, 2-3 year vessel time charter estimates

**Figure 44: Line 5 Shutdown Estimated Delivered Crude Costs[117]**

| Crude Supply Chain | Crude Volume (kpbd) | Logistics Costs ($/bbl) | Crude Price Before Logistics ($/bbl) | Delivered Cost Estimate ($/bbl) |
|---|---|---|---|---|
| Line 78 to Sarnia, ON | 218 | $79.53 | $4.68 | $84.21 |
| Line 78 to Nanticoke, ON | 75 | $79.53 | $5.00 | $84.53 |
| Line 78 to Toledo, OH | 131 | $79.53 | $5.71 | $85.24 |
| Line 78 to Detroit, MI | 82 | $79.53 | $6.54 | $86.07 |
| Line 78 to Warren, PA | 64 | $79.53 | $4.91 | $84.44 |
| USGC Waterborne to Quebec City | 183 | $84.75 | $2.80 | $87.55 |
| Waterborne to South Portland, Pipe to Montreal | 125 | $86.98 | $3.44 | $90.42 |
| Bakken crude unit train to Sarnia | 35 | $79.16 | $12.41 | $91.57 |
| Bakken crude unit train to Nanticoke | 20 | $79.16 | $13.24 | $92.40 |
| Bakken crude unit train to Toledo | 35 | $79.16 | $12.65 | $91.81 |
| Other Crude Oil Pipelines | 165 | $82.53 | $2.98 | $85.51 |
| **Total-** | **1,133** | | Weighted Average- | **$86.52** |

Note that the PLG analysis shows that estimated price for delivered crude oil to Valero would decrease in the event of a Line 5 shutdown as Valero converts all of their inbound crude to receiving crude oil from USGC via vessels. One potential reason that Valero has not already completely switched away crude coming from Enbridge pipeline system and vessel move from end of Enbridge Line 9 at Montreal to their refinery in Quebec City is an existing volume commitment to Line 9. In the event of a Line 5 shutdown, PLG is assuming no continuing obligation for use of Line 9 for either Suncor-Montreal or Valero-Quebec City.

There are several other factors to consider when evaluating the landed cost of crude in a post-Line 5 future state:

*Potential Diminished Price Discounts on Western Canada Light Crudes vs. Other Supplies as a Result of the Trans Mountain Expansion*

The implications of the Trans Mountain expansion on the potential shutdown of Line 5 are significant, because without the price discounts the economic incentive for Line 5 area refineries to utilize western Canada crude will be diminished. The price of that crude is expected to be on par with other global and continental price benchmarks, which will make other supplies such as Bakken, USGC, and Brent equally or more attractive for refining. Should this dynamic play out, it means that utilizing other crude sources and associated logistics for Line 5 area refineries may be more economical anyway following a Line 5 shutdown.

*Advantaged Refining Margins in the Midwest and Ontario*

Refiners in the Midwest and Ontario typically have higher margins than counterparts in other regions.[118]

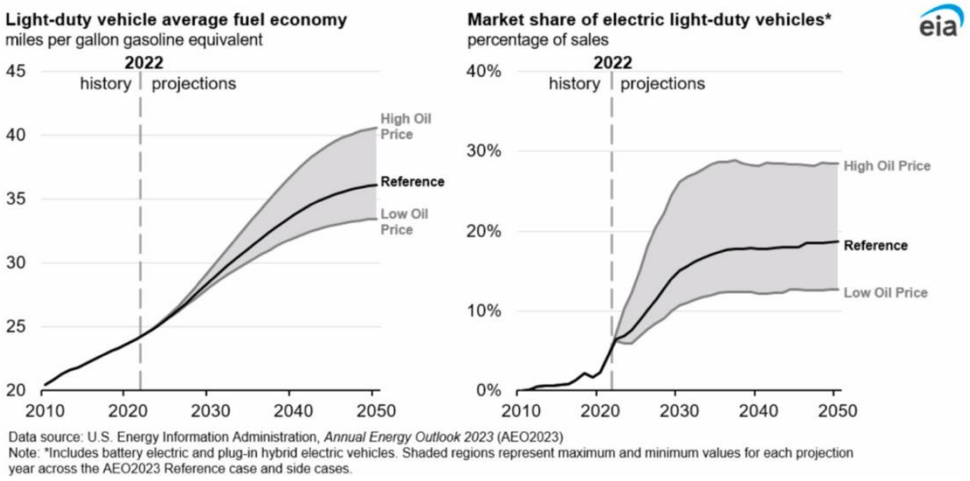
[117] PLG analysis using Enbridge and PMPL pipeline tariffs, CME and ICE 9/15/2023 July 2024 crude futures, Alberta Energy Regulator forecast for WTI-CLS, EIA North Dakota Crude Oil First Purchase Price vs. WTI, CME WTI Houston (Argus) vs. Brent July 2024 futures, railroad rates, railcar leasing quotes, 2-3 year vessel time charter estimates

[118] Expert Rebuttal Report of Sarah Emerson of ESAI (April 2022)

As such, even if the net landed crude costs increase for some refiners, those advantaged economics would likely allow refiners to absorb any crude cost increases and still remain profitable.

*Long-Term Implications of Decarbonization on Refined Fuels Demand*

**Figure 45: Light Duty Vehicle Fuel Economy Trends; EV Market Share[119]**



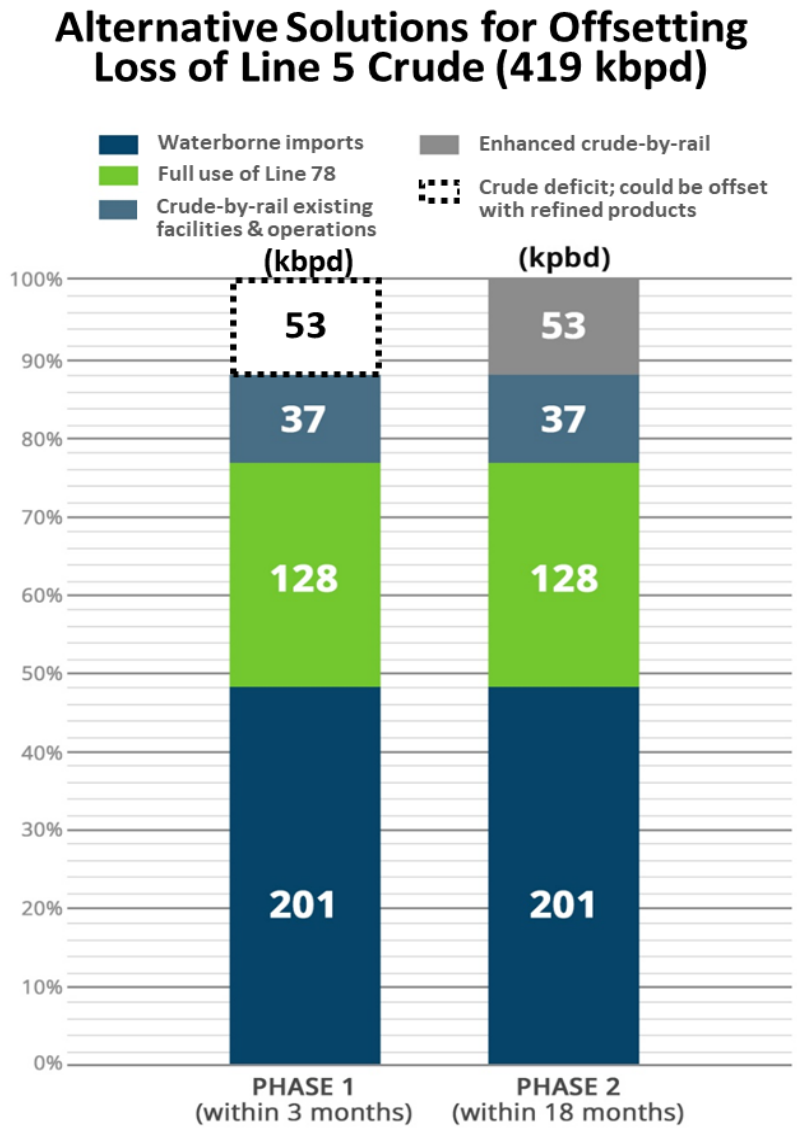

In addition to Canada's Clean Fuel Regulations that have recently been enacted and alluded to earlier, other long-term trends are working to diminish the overall use of refined fuels made from traditional hydrocarbons. Not only have vehicle fuel efficiency standards reduced demand for gasoline, but the rapidly growing market share for electric vehicles provides an additional macroeconomic factor that will cause the US and Canada to continue reducing refined fuels derived from fossil fuels.

## Summary of Phase I and Phase II Alternative Supply Chain Solutions for Crude Oil

The crude supply deficit created by a Line 5 shutdown, totaling approximately 419 kbpd, and the replenishment of that deficit provided by each of the Phase I and II solutions is summarized as follows:

[119] EIA, *Annual Energy Outlook* (March 2023)

**Figure 46: Summary of Alternative Phase I and II Supply Chain Solutions**




Under the combined Phase I and II solutions, the refineries in the Line 78/5 area would still enjoy commercially viable and operationally feasible supply chains for their crude oil feedstock.

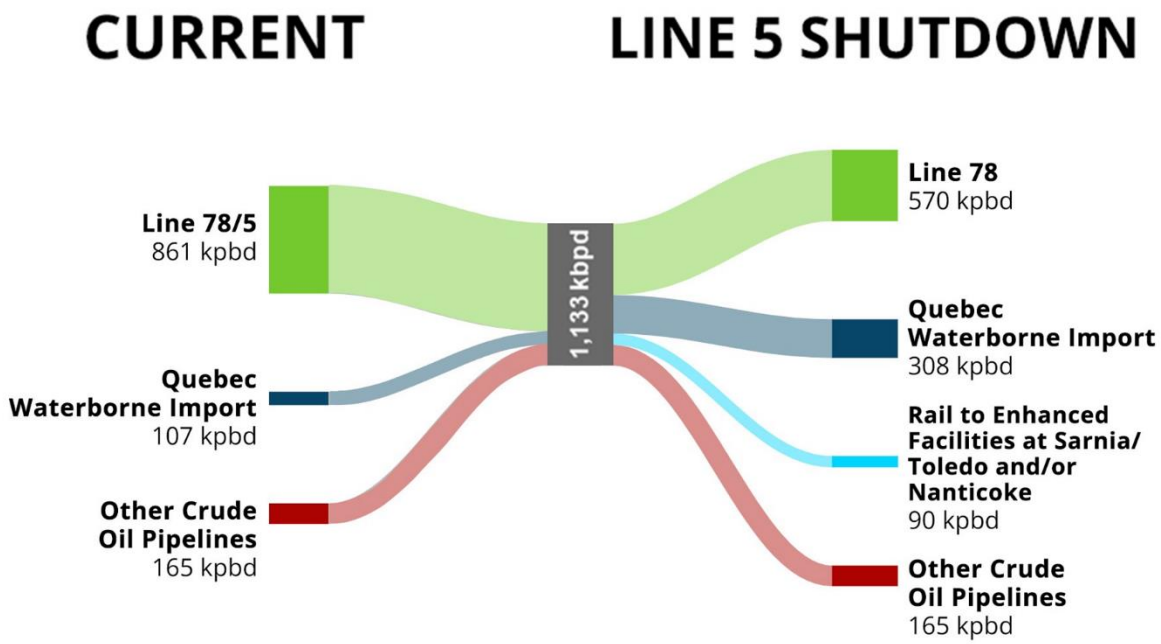
Key highlights:

- About 87% of crude supply replenishment is achieved under Phase I because those solutions rely on sourcing and logistics already employed by area refineries
- Crude supply shortfalls that might occur during Phase I may be offset in part by availability of refined products from other regions, which would only add about one half to one cent per gallon of gasoline[120]
- Following implementation of Phase II solutions, the average weighted cost per barrel would increase by $0.68/bbl

However, Phase I is not intended to be a race, but rather the first three months of a transition period. If the transition period were as long as 18 months before shutdown, the remaining crude shortfall can be more than accommodated by the Phase II solutions before a shutdown even occurs. The resulting reconfiguration of the comprehensive regional crude supply picture following implementation of Phase II alternative supply chain solutions can be visualized in Figure 47.

[120] Expert report of Neil Earnest of Muse, Stancil & Co. (January 2022); See pages 72–73.

**Figure 47: Current vs. Future Crude Oil Supply Chain for Line 5-Related Refineries In the Event of a Line 5 Shutdown and Following Phase II Implementation**




## Phase III Alternative Supply Chain Solutions for Crude Oil

Although Phase I and Phase II solutions fully satisfy the need for commercially feasible and operationally viable supply chain alternatives in the event of a potential Line 5 shutdown, there are some additional longer term options that the market may consider.

As described earlier, Phase III solutions are those that may involve longer-term investments or assume entirely new approaches to the provision of replacement product to Line 5 markets in order to meet various objectives such as increasing overall capacity to the market or lowering average per barrel costs. However, it should be reiterated that the entirety of the shortfall created by a potential Line 5 shutdown would be fully replenished by the Phase I and II solutions described above. Still, with regard to crude and its downstream refined products (primarily gasoline, diesel, and jet fuel), should market conditions warrant, there are three Phase III solutions available: **Expanding Line 78, re-reversal of Line 9, and switching Line 78 heavy crude to rail.**

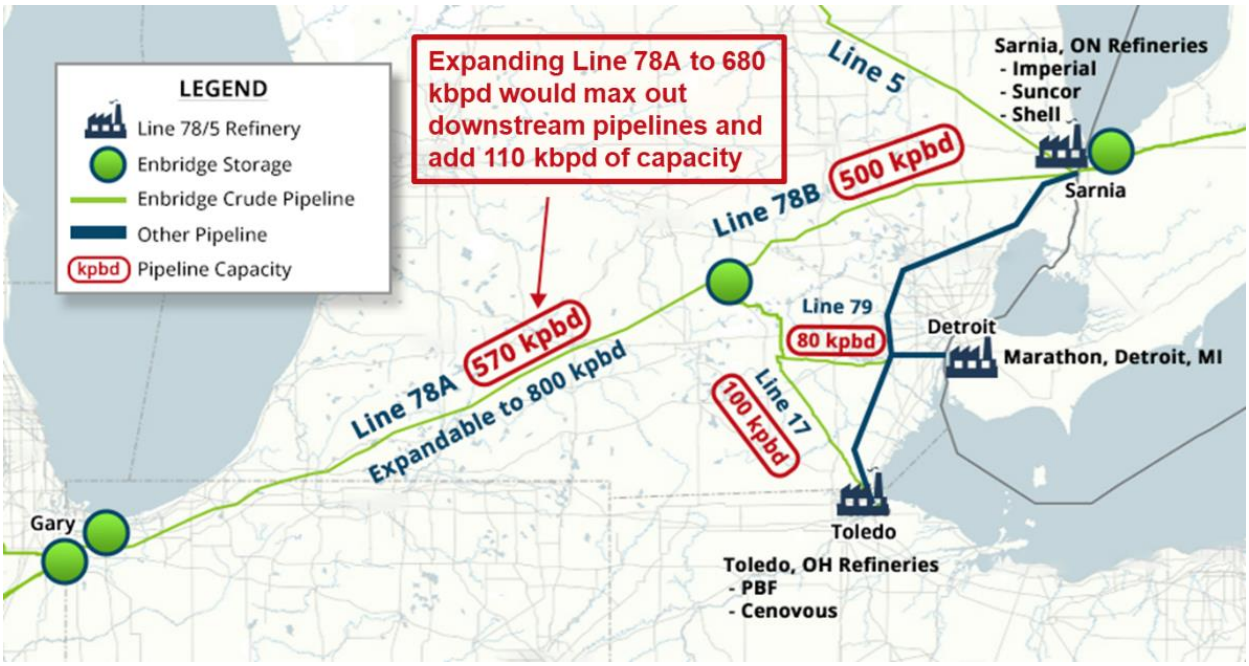
An explanation of each of these Phase III solutions is provided below:

1. **Expansion of Line 78**

As demonstrated above, Phase I and II initiatives are sufficient to provide commercially viable and operationally feasible alternatives for Line 5 deliveries. If Line 5 is shut down then Line 78 becomes the primary (but not exclusive) pipeline delivering crude to the former Line 78/5 service area.

While Phase I solutions include operating Line 78 at its existing maximum capacity, for the longer term it is possible to increase Line 78's capacity through the installation of new pumps if warranted by demand and market conditions. A Line 78 expansion would mostly consist of the simpler process of increasing compression rather than replacing all of the pipe. Following an estimated 7-9 months construction time from regulatory approval, an expanded Line 78A would increase its capacity by 230 kbpd from 570 kbpd to 800 kbpd, although the total effective incremental additional volume from this expansion would actually be smaller at 110 kbpd due to the capacity constraints of downstream connecting pipelines[121]. Meanwhile, Line 78B is only able to gain an incremental additional 25 kbpd (and may take longer to complete than 78A), so taken together the expansion of Line 78 would net 135 kbpd of new capacity.

**Figure 48: Potential Line 78A Expansion**




### 2. Re-reversal of Line 9

Another potential Phase III option not requiring a new pipeline is the re-reversal of Line 9. Line 9 is a crude oil pipeline originating at Sarnia, ON and terminating at Montreal with a capacity of 300 kbpd. The pipeline was first built in 1976 to carry crude oil from Sarnia to Montreal. Its first reversal was in 1998 and it was then reversed again in 2015 back to its original flow direction. Reversing Line 9 another time could facilitate new crude flows to Sarnia, ON of approximately 300 kbpd, supplied by waterborne imports from the US and overseas sources once Quebec refineries are fully satisfied as part of the Phase I solution described earlier.

[121] Line 78A connects to downstream pipeline capacity of 680 kbpd (705 kbpd with expanded Line 78B); 680 kbpd (downstream) – 570 kbpd (current) = 110 kbpd of incremental capacity from Line 78A expansion

**Figure 49: Line 9 Re-Reversal Concept and Portland-Montreal Pipeline[122]**


3. **Switch of heavy crude from Line 78 to rail in order to create more capacity on Line 78 for light crudes**

Line 78 handles both heavy and light crudes, and the alternative supply chain solutions identified above to increase capacity on Line 78 in a Line 5 shutdown scenario assume that the line would continue to handle heavy crude as well as light. At present, it is estimated that of the total capacity of Line 78, 301 kbpd of that capacity is utilized for heavy crudes[123].

When heavy crudes (also called bitumen) are transported by pipeline, they must be mixed with a diluent (usually condensate or natural gasoline.) This additive is necessary to reduce the viscosity of the heavy crudes so that they can actually flow within the pipe. The ratio of crude to diluent in a pipeline is 70/30, which means that for every barrel transported via pipeline, only 70% of that product is actually the refinable crude. This 30% diluent content is sometimes referred to as a "diluent penalty" as the refineries do not want to buy diluent in Western Canada but it is required to receive the heavy crude from a pipeline – and its transportation cost is borne by the pipeline customer along with the bitumen. The demand for diluent in Western Canada is so large that diluent is shipped from the U.S. to Canada on two diluent pipelines (Cochin and Southern Lights).

An emerging technology that has begun to compete with pipeline transport of heavy crude mixed with diluent is the transport of heavy crude via rail, but mixed with only 5% diluent. This has become possible with the development of diluent recovery units (DRUs) operating in Alberta that take in crude oil piped in from Western Canada production and removes the majority of the diluent. The remaining mix of 95% bitumen plus only 5% of diluent reduces the diluent penalty accordingly, and can be loaded into

[122] Marathon (July 2017)
[123] Expert Report of Sarah Emerson of ESAI (January 2022)

coiled/lined[124] tank cars for shipment by rail. Terminal operator US Development (USD) and its partner Gibson Energy who pioneered DRU technology have trademarked the name DRUbit for this heavy crude oil (aka bitumen) with very little diluent.

Another variation of this approach to reduce diluent content is called "railbit" that uses a 83%/17% ratio of bitumen to diluent[125]. However, getting to 5% diluent achieves economics via rail that are competitive to pipeline. USD estimates that DRUbit by rail is slightly cheaper that pipeline for movements from Western Canada to USGC.[126] USD claims that their existing 50 kbpd DRU is very scalable and they are working with other customers for take-or-pay agreements for an additional 50 kbpd of DRU capacity. Furthermore, with a diluent content of only 5%, DRUbit is categorized as a non-hazardous, non-flammable product for rail transportation.

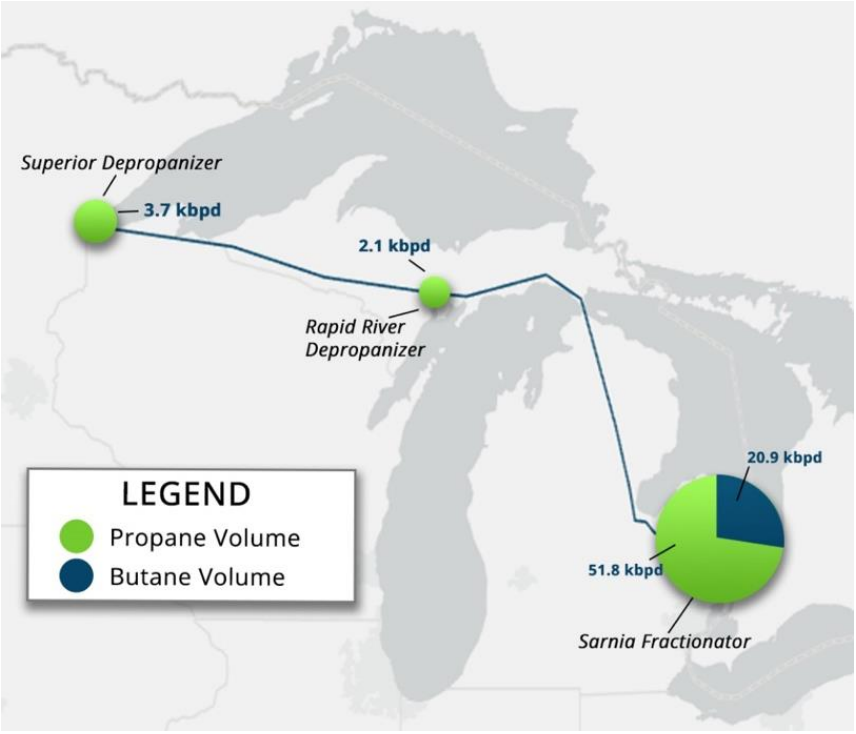
Conceptually, Line 78 refineries could switch some of their heavy crude supply chain from Line 78 to DRUbit rail deliveries, which would provide roughly the same landed cost while creating additional capacity on Line 78 for light crudes to be handled in the event of a Line 5 shutdown. Refineries receiving DRUbit would require crude-by-rail offloading facilities with steaming capability and steam-heated storage tanks due to the higher viscosity of DRUbit. Under this scenario, some of the 301 kbpd of heavy crude handled by on Line 78[127] today could convert to rail, allowing that capacity to be used for light crudes to the Line 78 region.

[124] Tank cars built to maintain product heat are equipped with heater coils that are usually charged with steam and also insulated linings that maintain heat during transport.
[125] RBN Energy, *Closer To Home, Part 2 - Gibson And USD Open A New Avenue For Alberta Bitumen To The Gulf Coast* (January 2022)
[126] USD Partners, *Investor Presentation* (May 2022)
[127] Expert Report of Sarah Emerson of ESAI (January 2022)

## NGLs

As established earlier, the NGLs mix that travels on Line 5 is almost exclusively composed of propane and butane and is estimated to be in the proportion of 57.6 and 20.9 kbpd, respectively (70.2% and 25.5%)[128]. Between Superior and Sarnia this mixed NGL stream is handled first at Superior, where 3.7 kbpd of propane is offloaded, and Rapid River, MI, where 2.1 kbpd of propane is offloaded. The remaining NGL mix continues to Sarnia where the fractionator produces about 52 kbpd of propane and 21 kbpd of butane from the Line 5 mixed NGLs that can be stored in storage caverns and/or distributed by outbound rail, pipeline, or truck.

**Figure 50: Line 5 Fractionators with Propane and Butane Throughput[129]**




In analyzing the various options for replacement supply of NGLs to the Line 5 market areas in the event of a Line 5 shutdown, it is important to underscore several key points:

- **The replacement volumes of NGLs do not need to come exclusively from Western Canada**. This is true for both the rural home heating needs of northern Wisconsin and the Upper Peninsula of Michigan, as well as the industrial, agricultural, and residential needs in Eastern Canada. There is a diverse range of source options that can provide resiliency and supply security of NGLs - particularly propane. And propane, like Canadian crude, is seeking export markets – particularly to Asia from the Canadian west coast.

### Western Canada is just one of several sources for propane supply.

- **The propane business is highly seasonal.** It is essential to note that, when it comes to propane consumption in North America, the business is highly seasonal. Any changes in supply sources and logistics must account for this factor by creating a consistency and reliability of both

[128] Total NGL volume of 82 kbpd on Line 5 and 70.2% is propane = 57.6 kbpd of total propane; 57.6 – 3.7 (Superior) – 2.1 (Rapid River) = 51.8 kbpd of propane delivered to Sarnia (Expert Report of Neil K. Earnest, January 2022; Expert Rebuttal Report of Jill Steiner, April 2022; Steiner Testimony, October 2022)

[129] Total NGL volume of 82 kbpd on Line 5 and 70.2% is propane = 57.6 kbpd of total propane; 57.6 – 3.7 (Superior) – 2.1 (Rapid River) = 51.8 kbpd of propane delivered to Sarnia (Expert Report of Neil K. Earnest, January 2022; Expert Rebuttal Report of Jill Steiner, April 2022; Steiner Testimony, October 2022)

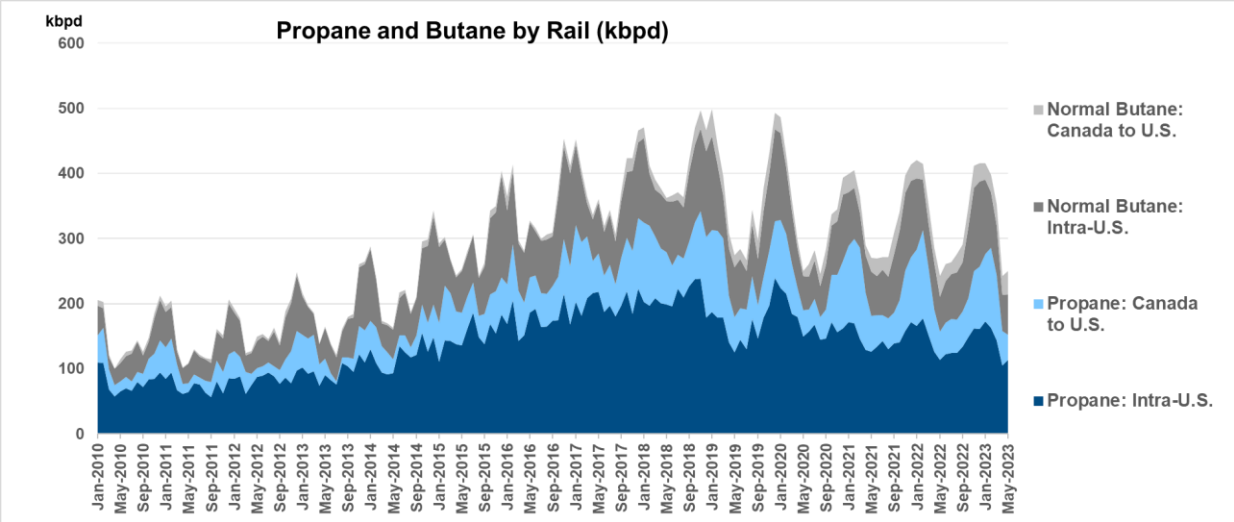
prepositioning product in various forms and locations for storage as well as delivery to end use customers – particularly for critical uses such as home heating. In identifying potential alternative supply chain solutions for the provision of NGLs to affected markets in the event of a Line 5 shutdown, this factor of seasonality was a key consideration in the strategies described below.

- **The ultimate goal is to deliver purity products**. If Line 5 shuts down, the market will most likely react by transporting purity propane and butane (i.e., propane and butane fractionated near the site of extraction) to the areas served by the Line 5 fractionators, as opposed to finding new means to transport the unfractionated NGLs. In other words, the ultimate goal is to delivery purity products to end customers: unless there is a reason to ship mixed NGLs to the affected market region, which would require the additional step of fractionation, it will be more efficient to ship purity products rather than mixed NGLs as Line 5 does today.

- **Rail is and will continue to be a primary means for delivery of NGLs to the Line 5 market area end-users and throughout North America.** With advance notice of a shutdown, the market will gravitate towards rail as the primary means of delivering this propane and butane—a mode of transport that is the most common means by which these products are transported from Canada to the United States and also from Alberta to the west coast for export.

Rail is and will continue to be a primary delivery means of propane to the Line 5-served markets.

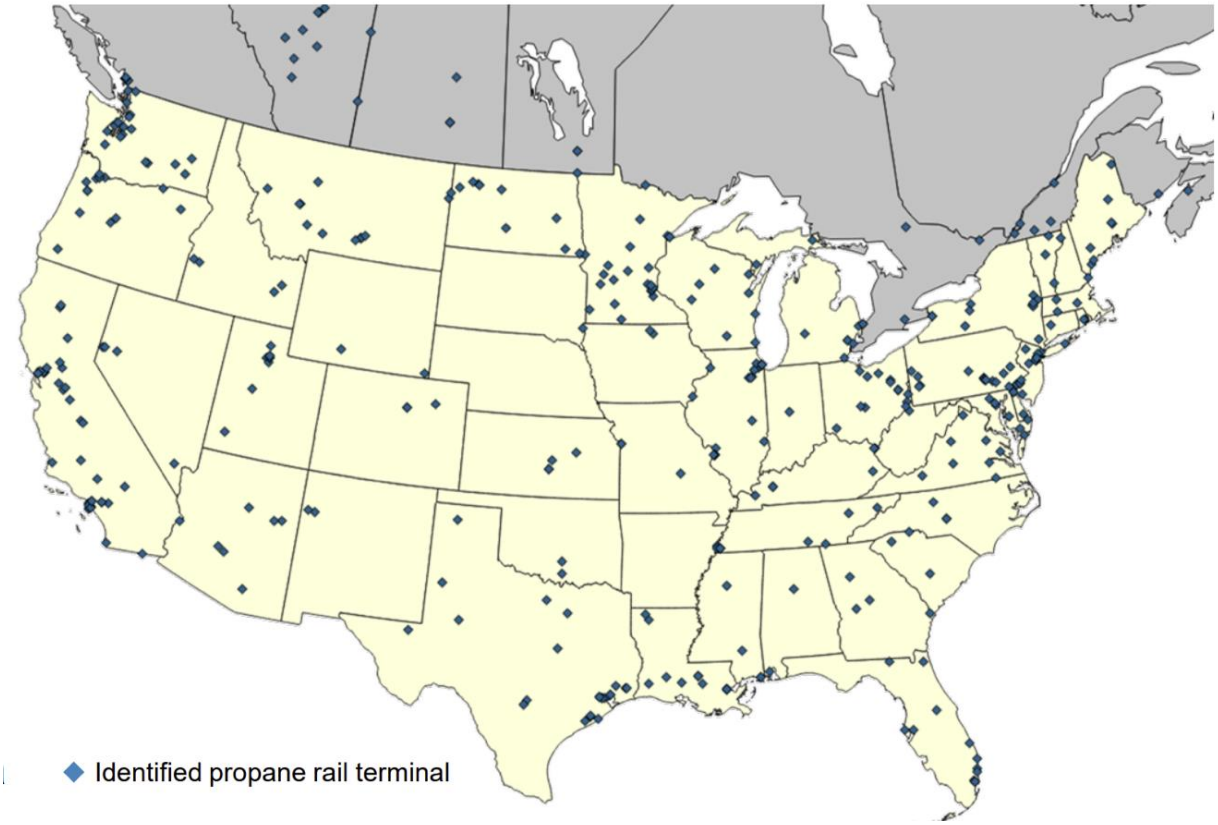
**Figure 51: Propane and Butane by Rail[130]**




And as indicated by the map in Figure 52, "final mile" of propane delivery to residential, agricultural, and industrial customers throughout the US and Canada takes place from the hundreds of rail distribution terminals on which both countries reliably count on for this essential energy supply.

[130] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023)

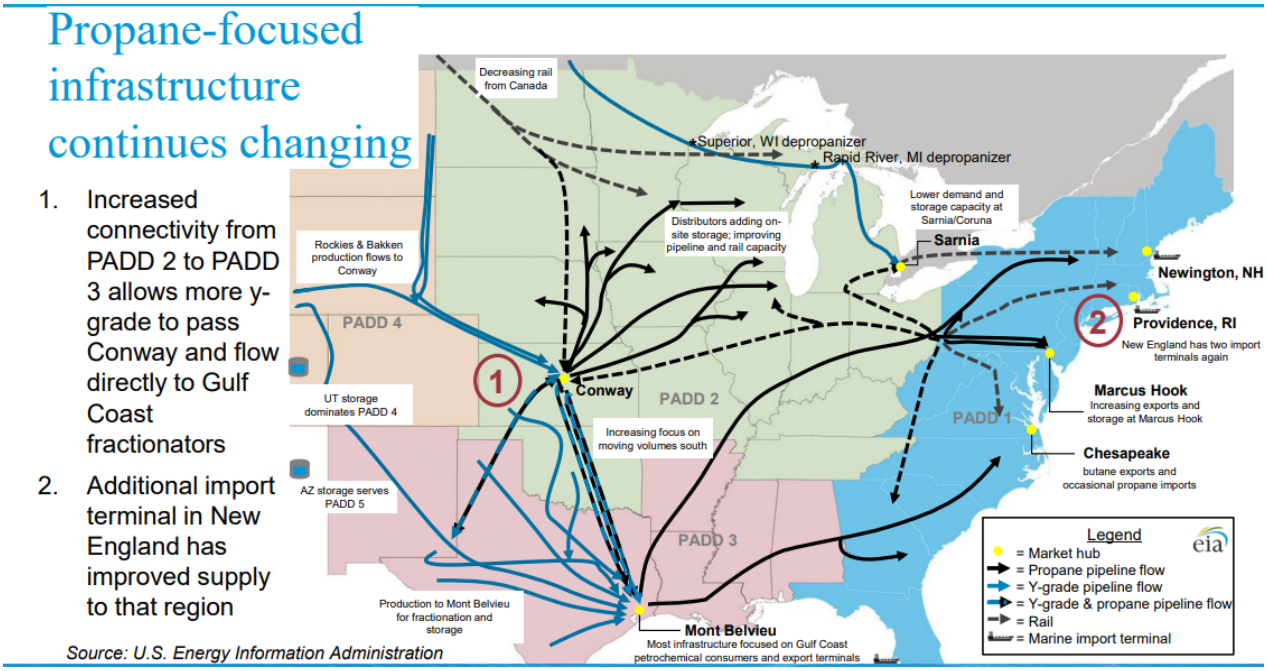
**Figure 52: Identified Propane Rail Terminals[131]**




- **The NGL supply chain features all of the characteristics of resiliency and adaptability as other hydrocarbon supply chains.** As demonstrated in Figure 53, there have been numerous evolutions in the flow of NGLs, particularly propane, as new logistics routes and nodes were established to accommodate increasing production in recent years.

[131] EIA, *Propane Market Fundamentals* (November 2019)

**Figure 53: Propane Infrastructure**[132]



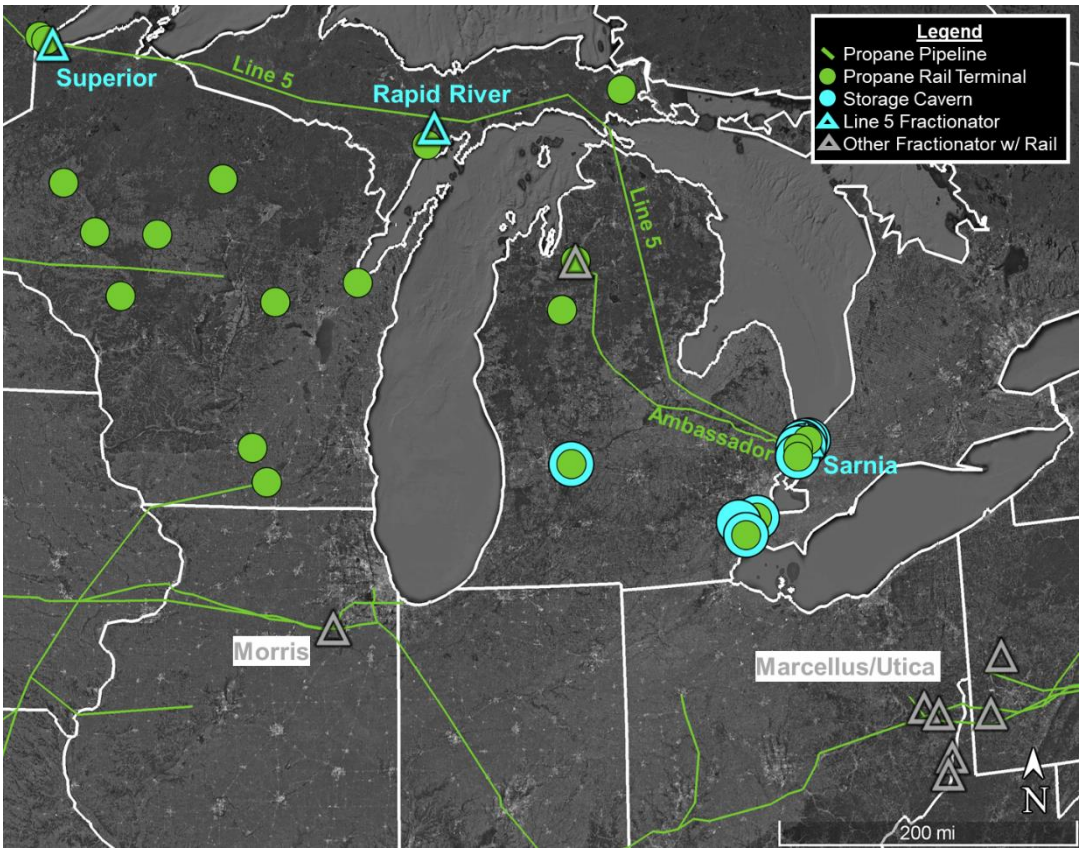

- **Line 5 services two distinct NGL markets** that must be analyzed separately**.** For propane in particular, the analysis of Phase I, II, and III alternative solutions must be separated by the two distinct markets that Line 5 serves:

  1) **The residential propane distribution to northern Wisconsin and the Upper Peninsula and northern Lower Peninsula of Michigan**, and

  2) the **combined industrial and residential distribution that occurs from the storage caverns within the greater Sarnia/Port Huron area where propane is stored in preparation for the wintertime peak heating season.**

[132] EIA, *Winter 2020-21 Mid-Season* Review (January 2021)

**Figure 54: Propane Infrastructure Within the Line 5 Service Area[133]**




The markets are quite different in terms of volume and existing logistics infrastructure and the alternative solutions for each are addressed separately and in detail below.

### Alternative solutions for Propane delivery to Wisconsin, the Upper Peninsula, and Northern Michigan

In the event of a Line 5 shutdown, the depropanization and distribution hubs of Superior[134] and Rapid River would no longer be supplied by pipeline. However, the existing storage tanks at those locations are still able to be used, albeit with different inbound transportation modes – primarily rail. And, the existing rail-to-truck propane terminals at Escanaba, MI and Kincheloe, MI will become fully utilized and potentially expanded.

### Phase I Immediate (within three months) Term Alternative Supply Chain Solutions for Propane Delivery to Wisconsin, the Upper Peninsula, and Northern Michigan

The Phase I solutions that are available for implementation immediately are:

1. **Fully utilize existing rail terminal facilities, and**

[133] PLG Analysis, EIA, Google Earth (August 2023)

[134] Assuming that NGLs no longer are transported on the Enbridge main line to Superior, but the option exists to continue to receive NGLs at Superior and create a rail-served distribution hub at that location.

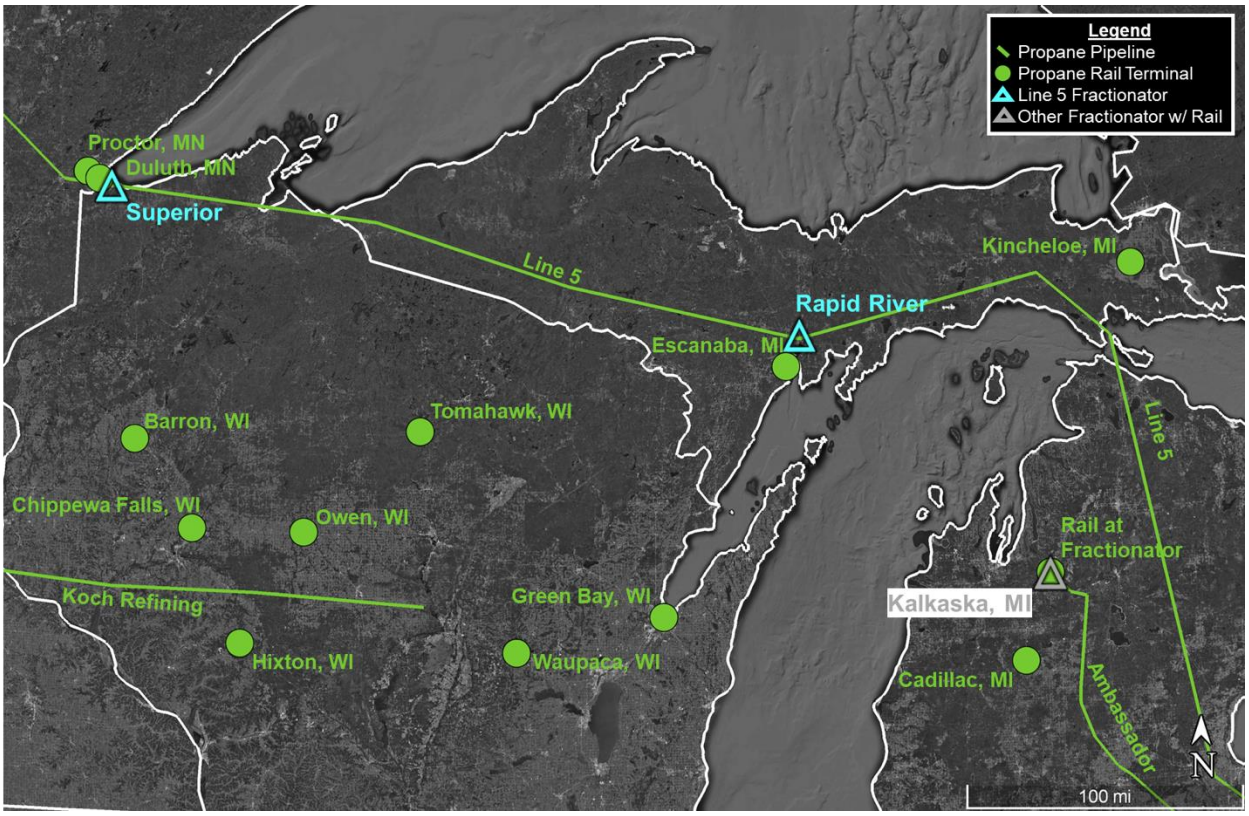
2. **Fully utilize the Ambassador distribution hub at Kalkaska, MI.**

Both of these concepts are discussed in detail below:

1. **Fully utilize existing rail terminal facilities within the region**.

As mentioned earlier and shown in Figure 55, rail distribution of propane to rural areas, which utilizes terminals that can offload the product, provide storage, and load into trucks, are the most common way in which propane is delivered to rural areas in the US and Canada. Even in the Upper Peninsula of Michigan for which the Rapid River fractionator supplies about 2/3 of propane demand, rail fulfills most of the remaining demand via existing rail terminals at Kincheloe, MI and Escanaba, MI.[135] However, they are not the only existing propane rail distribution terminals in the northern Wisconsin and northern Michigan Line 5 service area. Rail-served propane terminals also exist at Proctor, MN, Duluth, MN, Kalkaska, MI, and Tomahawk, WI, and are part of the broader propane distribution network. Superior Fuel has a rail unloading terminal in Duluth, MN with a storage capacity of nearly one million gallons of propane. NGL Supply Co. bought the Kincheloe terminal in 2019 with plans to upgrade the terminal[136].

**Figure 55: Propane Infrastructure Northern Michigan and Wisconsin Area[137]**



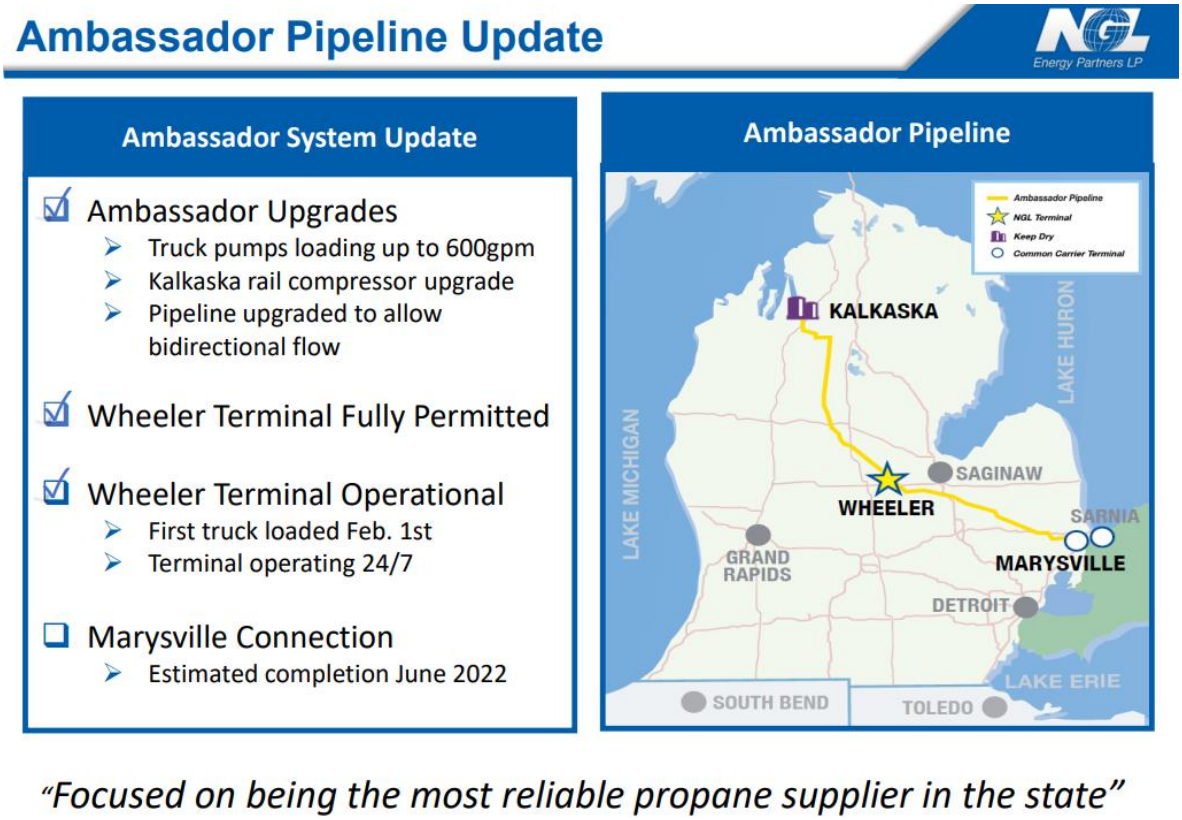

[135] Michigan Department of Transportation Office of Rail, *Propane by Rail in Michigan's Upper Peninsula* (November 2021)
[136] NGL Supply Co. Ltd., *NGL Supply Buys Plains' Kincheloe, Michigan, Propane Rail Terminal* (November 2019)
[137] PLG Analysis, EIA, Google Earth (September 2023)

In the event of a Line 5 shutdown, rail would be an ideal means of replacing the lost volume from the Rapid River depropanizer but to do so would require using existing rail terminals to their maximum capacity or, as discussed in Phase II solutions, the expansion of one or more terminals.

2. **Fully utilize Ambassador Pipeline distribution hub at Kalkaska, MI**. This rail, pipe, and truck facility offers robust connectivity in the northern lower peninsula of Michigan.

The Ambassador pipeline is a bi-directional pipeline with current capacity of 15 kbpd (which could be increased with additional pumps[138]) that goes from its rail-served fractionator at Kalkaska to the storage caverns in the Sarnia/Marysville area. The rail infrastructure at Kalkaska has recently been upgraded and the connection to Sarnia/Marysville was also completed in August 2022, allowing for flows into Sarnia/Marysville storage in the summer and out of Sarnia/Marysville during the winter. In addition, a terminal at Wheeler, MI – roughly the midpoint of the pipeline – has truck loading capability plus 480,000 gallons of storage. Both Wheeler and Kalkaska each utilize two truck loading bays capable of flowing up to 600 gallons per minute, which allows propane transports to load in approximately 25 minutes.[139]

**Figure 56: Ambassador Pipeline and Related Facilities[140]**



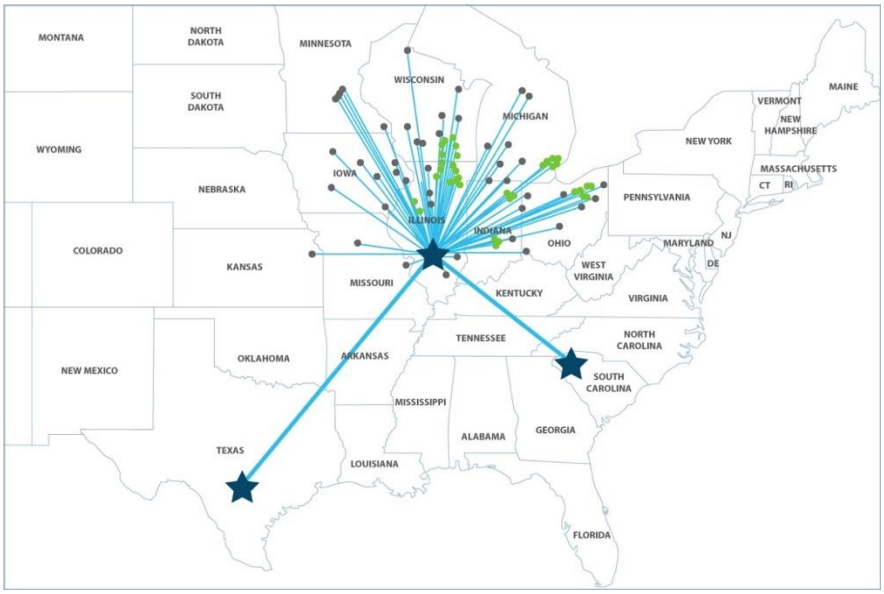

[138] Expansion with additional pumps would require a longer period than three months to implement
[139] NGL Energy Partners LP, *NGL Energy Partners LP Announces the Ambassador Pipeline Placed in Service* (August 2022)
[140] Michigan Public Service Commission, *UP Propane System* (August 2019)

### 3. Expand existing or build one or more additional rail terminals in the region.

In the event of a Line 5 shutdown, the approximately 2.1 kbpd of propane supplied to the Upper Peninsula and northern Wisconsin by the Plains fractionator at Rapid River would need to be instead provided by rail. While existing rail transload facilities at Escanaba and Kincheloe can be utilized to their full extent, **notice of a shutdown occurring in the near term (or, of course, a shutdown itself) would likely prompt a network design analysis to determine the optimal location of a new facility** (or expansion of an existing one).

Location decisions for bulk terminals, including those for propane, are usually dictated by available infrastructure and property as well as supply and demand modeling. To determine the optimal location of such facilities, a network optimization analysis would be done that takes into account all of the end delivery points and their respective volumes, and then uses modeling to determine optimal locations for additional terminals based on weighted average of total delivery costs. The process of network design optimization would utilize final destination and volume data from propane wholesalers and retailers in the region to create a ton-center analysis of demand. From there, the analysis would be compared against already known potential facility locations to determine an optimal site. As a general rule for such network optimization efforts involving rail-to-truck transloading, the rail aspects are optimized for economies of scale (i.e. increasing volume to the extent possible over any fixed investment costs), and minimizing to the extent possible the major operating cost variable of such operations, truck miles.

**Figure 57: Representative Example Output of Rail-Truck Distribution Terminal Network Modeling**




The goal of network optimization modeling is to achieve the lowest weighted average cost of delivery and can be performed across a virtually unlimited set of destinations and tested against a virtually unlimited set of origin locations (which would be, in this case, a potential new or expanded rail propane distribution site). A representative example of such modeling output is shown in Figure 57. The modeling can also optimize the balancing of demand across multiple rail terminals. The caveat to such modeling is that nominated locations cannot be hypothetical; they must of course be actual locations on or nearby to existing rail lines that can be developed as propane terminals.

Fortunately, prior analysis by the Michigan Department of Transportation prepared a report in 2021 that identified candidate locations for new or expanded propane-by-rail terminals surfaced at least six options in the central and west areas of the Upper Peninsula, which would complement the existing facilities in Kincheloe (east) and Escanaba (south central).[141] It is likely that one or more of those locations would fall within an optimization strike zone once the ton center analysis data is reviewed.

## At least six candidate location options have been identified for additional propane rail terminal(s) in the Upper Peninsula.

Construction of these straightforward facilities typically can be done at cost of $ 5-10MM, depending on the amount of track and storage that is built and number of unloading racks. The $10MM figure would provide for a larger facility capable of accommodating 11-15 kbpd, about three times more than the historical peak demand of the Rapid River fractionator. Fixed tanks can be installed to provide multiple days of on-hand storage, in addition to enough railcar spots to accommodate any bunching or other variance in rail service. The estimated completion time for construction is 12-18 months, depending on what existing infrastructure might already exist on a selected site.

**Figure 58: Representative Example of Propane Rail Terminal[142]**

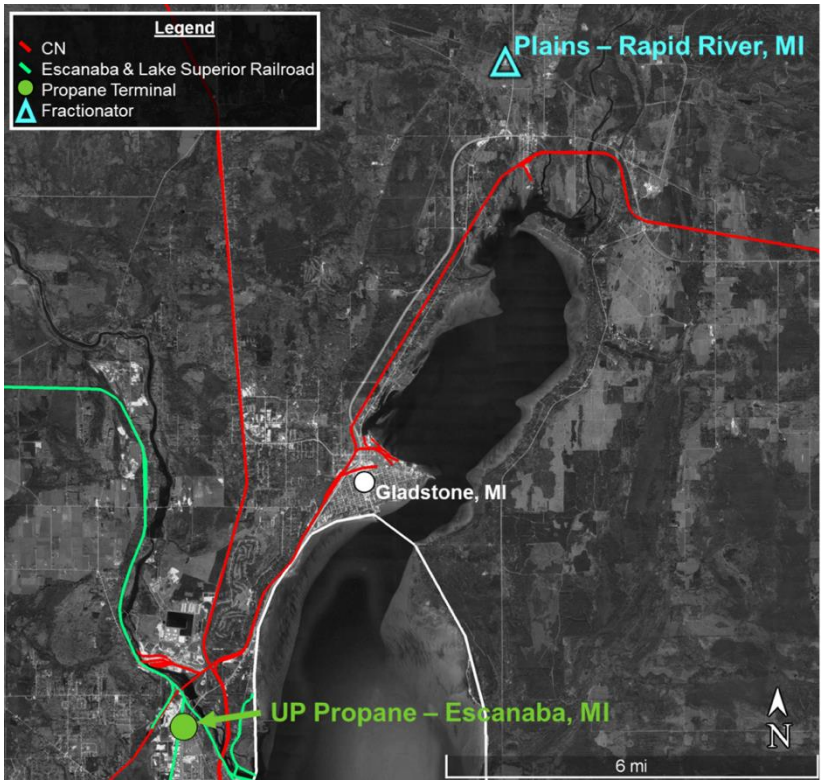
Even with the depropanizers operating at Superior, WI and Rapid River, MI on Line 5, the industry continued to develop and expand rail transload facilities in the market region for the past several years to help bolster product availability when, at times, even the fractionators at Superior and Rapid River were unable to deliver sufficient volumes[143]. The combined volume of those facilities would likely be best replaced by at least one additional new rail terminal, assuming that the existing facilities are operated at their maximum throughput and the network optimization modeling can inform the ideal location(s) of such new terminal(s).

It is possible that a new rail terminal in the area of Rapid River depropanizer could be beneficial as a way to utilize the existing storage at the facility even if the fractionator ceases to operate. Truck shuttle operations could link a nearby propane by rail facility with the storage assets at Rapid River. The

[141] Michigan Public Service Commission, *UP Propane System* (August 2019)
[142] TransTech Energy, *Truck and Rail Terminals* (Retrieved October 2023)
[143] Michigan Public Service Commission, *UP Propane System* (August 2019)

communities of Escanaba, MI and Gladstone, MI, within 15 miles of Rapid River, are locations with significant rail infrastructure for accommodating a potential transload site (Figure 59) and in the case of Escanaba there is already an existing propane rail terminal. Conversely, it would also be possible to relocate some of the bullet storage tanks at Rapid River to existing or future rail terminals.

**Figure 59: Rail Network and Existing Propane Rail Transload Facility Near Rapid River[144]**

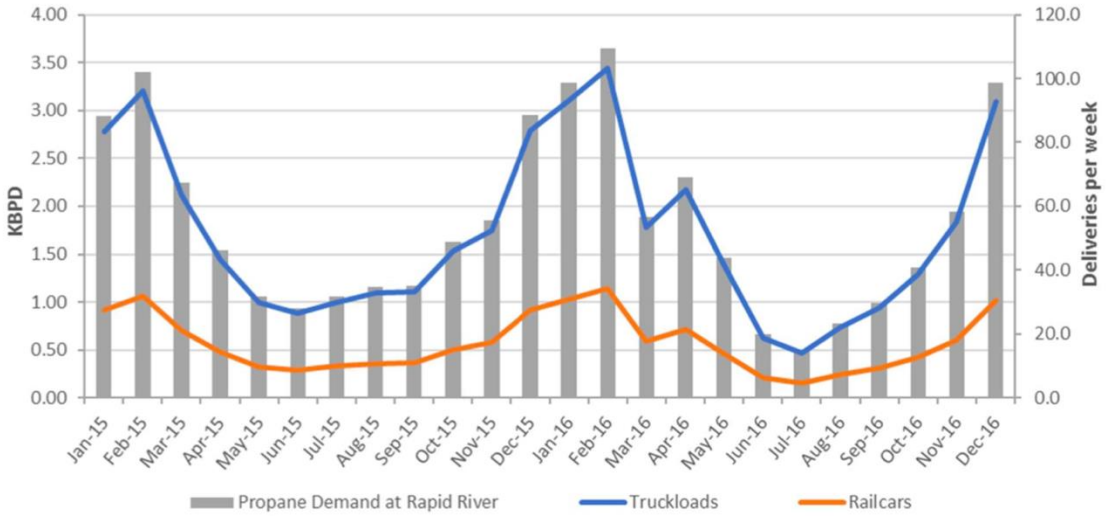



Ultimately the total volume that would need to be handled via a new or expanded propane rail terminal is the relatively small level of up to five railcars per day based on historical peak demand (Figure 60) and accounting for recent increases and contingency. Provided that sufficient above-ground storage tanks are installed and in combination with 50 car spots[145] for loaded and empty storage plus the necessary equipment for the facility to handle cars within its plant, a terminal of this kind could readily handle any shortfall of propane for the region in the event of a Line 5 shutdown.

[144] Google Earth, PLG Analysis (September 2023)

[145] 50 car spots would provide for five days' worth of variability from periodic service or "bunching" of cars issues

**Figure 60: Historical Propane Demand at Rapid River With Truckload and Railcar Equivalent Counts[146]**



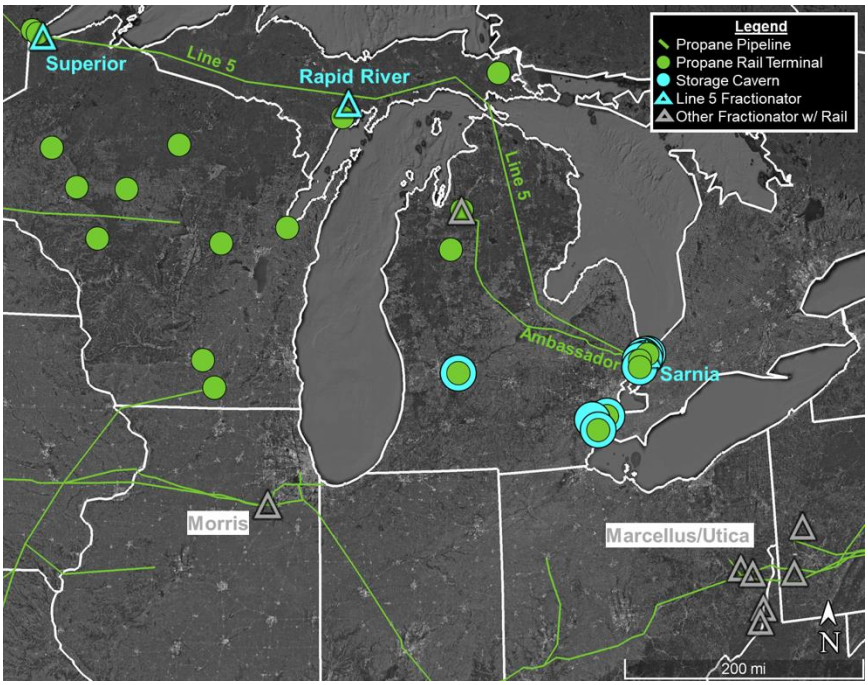

## Alternative Solutions for Propane Delivery to Storage Caverns in the Greater Sarnia/Port Huron Area and Direct-Shipment to End Use Customers

In evaluating alternative solutions that are available for delivery of propane and butane to the Sarnia and eastern Michigan areas in the event of a Line 5 shutdown, there are several factors to consider:

- As established earlier, Line 5 delivers a mixed NGL stream to Sarnia consisting of propane and butane. The Plains-Sarnia fractionator's purpose is to separate those mixed NGLs (propane and butane) from Line 5 into their purity products so that they may be further delivered downstream to businesses and residences in parts of Michigan, Ontario and eastern Canada, and, to some extent, New England.

[146] Michigan Department of Transportation Office of Rail, *Propane by Rail in Michigan's Upper Peninsula* (November 2021) citing Michigan Public Service Commission and Dynamic Risk Assessment Systems, Inc.

**Figure 61: Propane Infrastructure Within the Line 5 Service Area[147]**

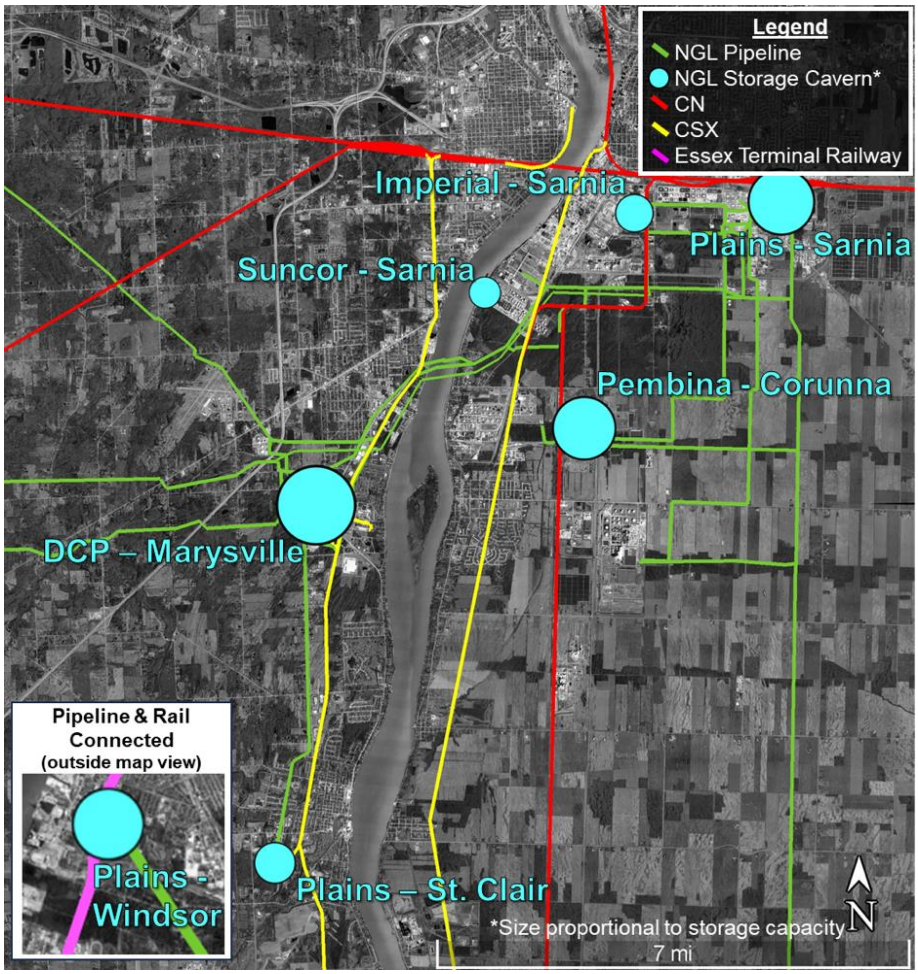



- However, **the task of fractionation is an intermediate step that would not be necessary at Sarnia if purity propane is supplied to this area by means other than Line 5**, i.e. direct delivery of the already fractionated purity product either to Sarnia for interim storage *or* directly to the end customers (bypassing Sarnia altogether). As such**, even if a potential Line 5 shutdown were to reduce operations of the Plains-Sarnia fractionator, it does not mean that end use customers would lose access to supply because already fractionated propane is available from other sources as described below.**

- **Plains-Sarnia is just one of five large scale non-refinery storage caverns in the Sarnia/Port Huron/Windsor area** (in addition to DCP-Marysville, Pembina-Corunna, Plains-Windsor, and Plains-St. Clair) that are interconnected and allow for accumulation of propane throughout the year for subsequent dispatch, primarily via rail, to end use customers during the peak season of roughly September 1st to May 1st. A small proportion of the propane is sent via pipeline locally in Sarnia for industrial use.

[147] PLG Analysis, EIA, Google Earth (August 2023)

**Figure 62: Sarnia/Port Huron/Windsor Area NGL Storage Caverns, Pipelines and Railroads[148]**




The combination of these factors mean that, **even if Line 5 were to shut down and the Plains-Sarnia fractionator were to close or reduce operations as a result, the *storage facilities* can continue to operate** and in fact Plains-Sarnia is just one of five large scale NGL storage caverns in the area with both inbound and outbound rail capability. Thus, **producers, wholesalers, retailers, and consumers can still enjoy the strategic benefit of large propane storage and distribution for the Line 5 market area, even without Line 5 or the fractionation activity at Plains-Sarnia.** The supply chain options available to support that continued benefit are detailed below.

## Phase I Immediate Term (within three months) Alternative Supply Chain Solutions for Propane Delivery to Sarnia Area Storage Caverns and Direct-Shipment to Customers

There are two major supply chain strategies available immediately that would help address a potential Line 5 shutdown. Each of these strategies involve the use of rail and also takes into account the seasonal nature of propane markets.

The first strategy enables the continued use of Sarnia/Port Huron/Windsor area storage caverns in order to build seasonal inventories, and the second strategy takes a certain portion of the volume presently transiting Sarnia/Port Huron/Windsor area storage caverns and bypasses it in direct-shipments between production area and end-use customer. Those strategies are:

1. **Delivery of propane via rail to all five of the Sarnia/Port Huron/Windsor area storage caverns**, mainly during summer, and

[148] EIA, PLG Analysis, Google Earth (September 2023)

2. **Direct-shipment of purity product from NGLs production areas to Line 5 propane markets,** particularly during peak demand season.

Both of these Phase I options are described in detail below.

### 1. Deliver propane via rail to all five of the interconnected propane storage caverns in the Sarnia/Port Huron/Windsor area.

While today the mixed NGL stream from Line 5 is delivered first to the fractionator at Sarnia followed by injection of purity propane into the Plains-Sarnia storage cavern, **it is possible to deliver propane via rail to all five of the interconnected area storage caverns.** This activity would build storage within the region throughout the year (but mainly between May 1 and September 1) and provide a consistent flow of the purity product into storage without needing the fractionation function of the Sarnia fractionator, effectively replacing the Line 5 mixed NGL flow with purity propane direct-delivered to storage as well as to end-use customers. As established earlier, this solution is possible because:

- **All five of the large storage facilities are rail-served today**, and have equipment to receive inbound rail shipments of propane in addition to loading outbound railcars**.**

All of the major NGL storage facilities in the Sarnia/Port Huron/Windsor area are served by rail.

- The rail-delivered replacement propane need not come all the way from Alberta, although western Canada could certainly remain a part of the supply mix. Closer sources include the Bakken shale play; the major storage and fractionation hub of Conway, KS; the pipeline terminus, fractionation, and rail-loadout hub of Morris, IL (Figure 63); the major storage hub at Marcus Hook, PA, and the Marcellus/Utica shale play in Ohio, Pennsylvania, and West Virginia. In the Bakken for example, Marathon has a unit train-loading terminal in Fryburg, ND that is capable of handling propane[149].

**Figure 63: Aux Sable East Morris, IL Rail Infrastructure[150]**

- There is significant propane and butane rail loading in Western Canada should that region remain a primary supply source. One example is the Pembina Redwater, AB propane unit train facility, which can ship 105-car unit trains.[151] Pembina-Corunna could utilize Cando's nearby

[149] RBN Energy, *Long Train Runnin', Part 2 - The Economics Of Bakken-To-Mexico Propane Unit Trains* (August 2019)
[150] Google Earth (April 2017 Imagery)
[151] Pembina, *Pembina Pipeline Corporation is Shipping Propane to Ease Quebec's Fuel Shortage* (November 2019)

terminal to land propane unit trains and then transfer blocks of railcars between the Cando facility and Pembina-Corunna to unload the train (Figure 64).

**Figure 64: Cando and Pembina Proximity in Corunna[152]**


The Marcellus/Utica shale play in particular features both abundant NGLs supply and rail loadout capability, and is especially well-positioned as an alternative supply source of NGLs for Sarnia and Eastern Canada/New England markets due to three factors:

- **It is the closest production area of NGLs to Sarnia and the eastern US and Canada;**
- **It is one of the U.S.'s largest production area of NGLs**, with surging output that vastly exceeds domestic demand, and
- **There is extensive storage and rail loadout capability,** the latter of which is significantly underutilized due to pipeline expansions in recent years that has idled large amounts of rail rack and storage capacity.

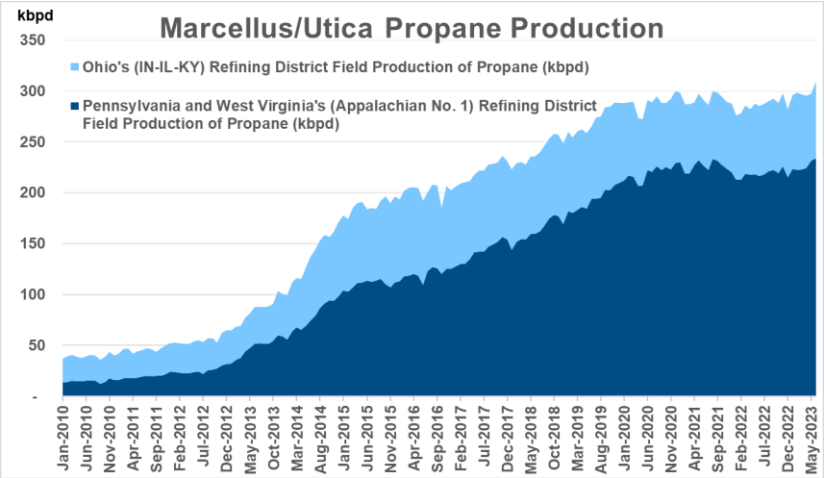
Surging production has achieved energy independence for North America.

## Overview of Marcellus/Utica as a Potential Supply Source for NGLs to the Line 5 Market Area

As part of the shale development phenomena beginning around 2011, the Marcellus and Utica shale regions have seen significant growth in their NGL production and processing capabilities. Figure 65 illustrates the significant growth of just propane in the two refining districts that include Marcellus/Utica.

[152] PLG Analysis, Google Earth (September 2023)

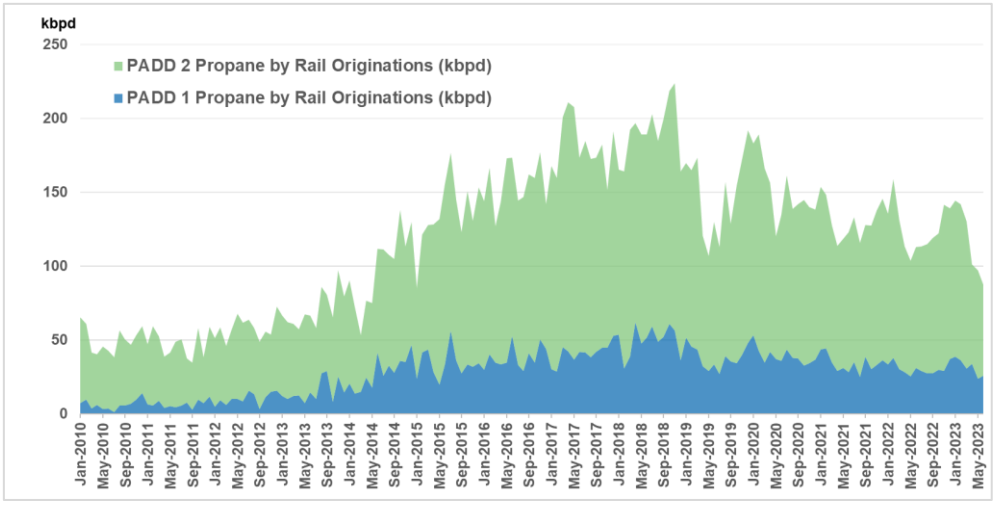
**Figure 65: Marcellus/Utica Propane Production[153]**




An example of significant infrastructure in the Marcellus/Utica is MPLX (master limited partnership formed by Marathon Petroleum Corporation) that has 531 kbpd of C2+ fractionation capacity in Marcellus and Utica[154]. This region has at least six major fractionators with a combined estimated storage capacity of 1,850 railcars.

This massive rail loadout capability in the Marcellus/Utica was initially developed to handle the surging production of NGLs prior to new pipeline takeaway capacity coming online. As illustrated in Figure 66, rail volumes for propane from the Marcellus/Utica peaked in November 2018, just before Energy Transfer's new Mariner East 2 pipeline was placed into operation. This 20" pipeline delivers batches of propane and butane to Marcus Hook, PA for export and has a capacity of 275 kbpd[155] – nearly four times the amount of propane and butane moved on Line 5. And, Marcus Hook itself can and does provide rail loadout for distribution to Canadian and domestic US markets.

**Figure 66: Propane by Rail From Marcellus/Utica PADDs[156]**

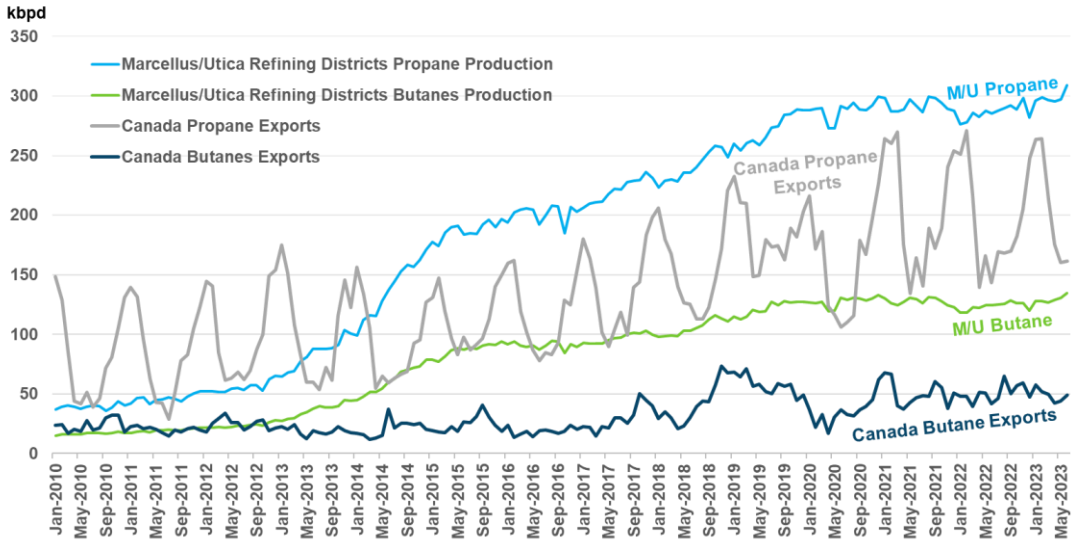



This has freed up significant capacity to originate new rail shipments from the Utica/Marcellus in the event that such shipments are necessitated by a Line 5 shutdown. While rail loadout demand from the Marcellus/Utica has diminished, the facilities and capacity remain in place for future use. And, outbound rail shipments continue to take place from

[153] EIA, *Natural Gas Plant Field Production* (August 2023) - Appalachian No. 1 is an EIA refining district that contains most of Pennsylvania, West Virginia, and part of New York. Indiana-Illinois-Kentucky is an EIA refining district containing Ohio and five other states. Super majority of growth is believed to be related to Marcellus/Utica.
[154] MPLX, *Marcellus/Utica Operations* (Retrieved September 2023)
[155] Energy Transfer LP, *2022 Form 10-K* (February 2023)
[156] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023) PADD 2 contains Ohio and Kentucky part of Marcellus/Utica and PADD 1 contains West Virginia, Pennsylvania and New York part of Marcellus/Utica.

Marcellus/Utica to North America locations, primarily of propane going to the multitude of rail distribution terminals as described above. Taken together, Canadian propane exports, which occur primarily via rail to either US destinations or export terminals in British Columbia, in combination with Marcellus/Utica propane production that continues to grow, provides supply optionality for the Line 5 market area in the event of a Line 5 shutdown (Figure 67).

**Figure 67: Marcellus/Utica Butanes and Propane Production; Canadian Butanes and Propane Exports[157]**




Examples of Marcellus/Utica rail loading infrastructure include MPLX's 500+ railcar spots and 84 railcar loading racks at Hopedale, OH, as illustrated in Figure 70. The rail loading infrastructure was originally primarily built to support export of NGLs from the East Coast prior to the construction of pipelines to facilitate those movements (in particular, the expansion of the Mariner East pipeline system). However, once the Mariner East 2 pipeline came online in 2018 with an initial capacity of 275 kbpd volume of rail loadings out of the Marcellus/Utica shale play declined. This reduction in rail loadings is demonstrated in Figure 66, illustrating NGL shipments from PADD 1 and PADD 2 (which both cover the Marcellus/Utica). The net effect of these volumes shifting from rail to pipe is the freeing up of significant rail loadout capacity from existing terminals in the region.

**Figure 68: MPLX - Evans City, PA Rail Infrastructure[158]**

[157] EIA, CER, PLG Analysis (September 2023)
[158] Google Earth (Retrieved September 2023)

**Figure 69: MPLX - Houston (Washington), PA Rail Infrastructure[159]**

**Figure 70: MPLX - Hopedale (Jewett), OH Rail Infrastructure[160]**

**Figure 71: Blue Racer – Proctor, WV Rail Infrastructure[161]**

In 2022, there were approximately 290 kbpd of HGLs[162] by rail[163] in Canada and 299 kbpd of HGLs[164] by rail intra-U.S. for a total of 589 kbpd of HGLs in Canada and U.S. This equates to well over 300,000 annual carloads. The vast majority of these movements are propane and normal butane but include other HGLs like isobutane and propylene. The 72.7 kbpd of propane and butane currently moved by Line 5 to Sarnia is largely already accounted for in these rail estimates, because the majority of that volume is eventually loaded into railcars from storage for shipment to final destination. **This storage-to-rail sequence could be replaced in part by rail-direct shipments from the production area(s) to end use customers**,

[159] Google Earth (Retrieved September 2023)
[160] Google Earth (Retrieved September 2023)
[161] Google Earth (Retrieved September 2023)
[162] HGLs are primarily NGLs but also includes olefins (like propylene) that also move in large pressurized railcars.
[163] Statistics Canada, *Railway carloadings statistics* (September 2023); PLG Analysis (153,671 railcars of gaseous hydrocarbons at an estimate of 690 bbls/railcar)
[164] EIA, *Movements of Crude Oil and Selected Products by Rail* (August 2023)

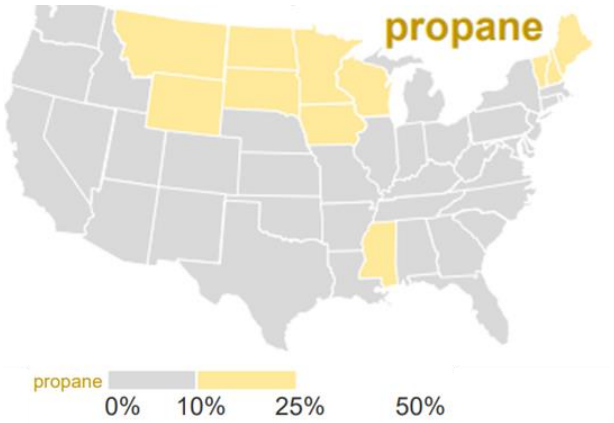
particularly during the peak winter season. For those volumes no new rail shipments are created that would not otherwise be happening, they would simply be starting from a new origin point.

**2. Ship purity propane from production areas, particularly the Marcellus/Utica, directly to end-use customers in New England and Eastern Canada**

Because greater Sarnia is not a production area for propane but rather the location of significant storage, the need for that storage could be reduced somewhat if producers in the Utica/Marcellus and other production areas (including western Canada) were to ship directly to the destination terminals in the event of a Line 5 shutdown. In other words, **while a majority of propane supply may still go to the Sarnia area storage caverns before being shipped by rail to destinations, some volume can bypass Sarnia storage altogether and go directly to end customers.** As a general rule, most summer propane production for this demand would be sent to Sarnia for storage when propane demand is lower, and most winter propane production for this demand would go directly to end-use customers.

As mentioned earlier, North America propane production vastly exceeds domestic demand, which has led to significant export shipments from the West, East and Gulf coasts. Propane production has grown dramatically in recent years in the Utica/Marcellus region, and presently that production serves regional customers and the excess is sent via pipeline to the east coast for export.

**Figure 72: Primary Home Heating Fuel by State (2021)[165]**

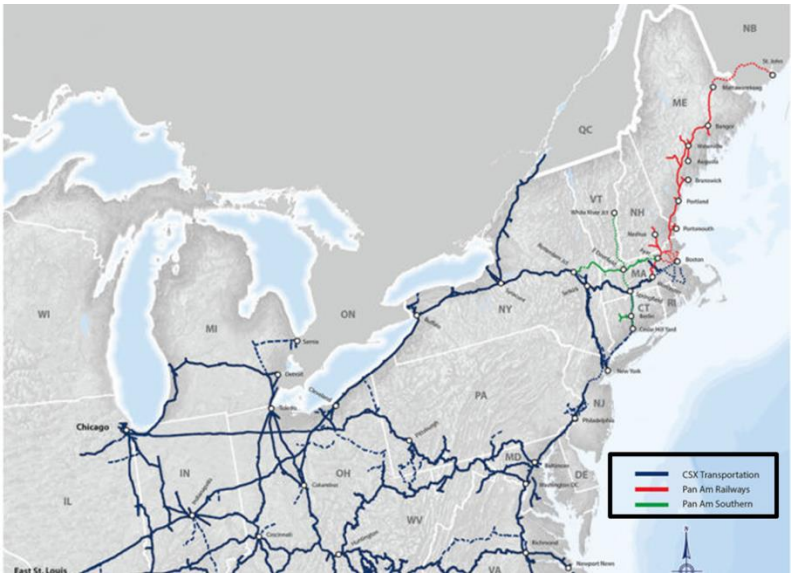



Under a potential Line 5 shutdown, direct-shipment activity to Line 5 markets in eastern Canada and New England would likely still originate partly from western Canada but also include Marcellus/Utica. This opportunity for direct-shipment is also available from Morris, IL, where rail loadout takes place from pipeline and fractionation capacity that is serviced by Canadian National Railway – enabling an efficient single-line haul to eastern Canada. Rail loadout can also take place from storage caverns at Marcus Hook, PA, which are fed by pipeline from the Marcellus/Utica.

Direct shipment from the Marcellus/Utica (or, by extension, the storage and terminal infrastructure at Marcus Hook, PA that is pipeline-connected to the Marcellus/Utica) to US and Canadian customers would likely replace some but not all of the volume presently provided by Sarnia, and the opportunity to sell to export markets would continue. But this option would reduce the need to use the storage at Sarnia, and also ease some of the new inbound rail volumes that would be needed to supply those storage caverns in the event of a Line 5 shutdown.

[165] U.S. Census Bureau, American Community Survey (ACS) 2021, EIA (October 2022)

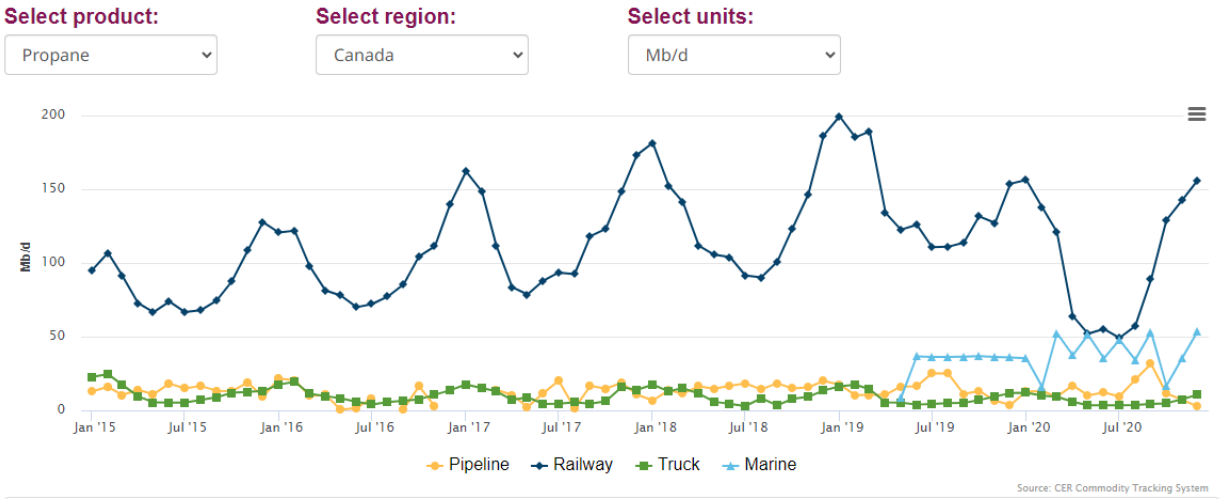
**Figure 73: CSX – Pan Am Railways Merger Map[166]**




The ability of the Marcellus/Utica shale play to serve New England propane markets has been recently enhanced by the 2023 acquisition of Pan Am Railways by CSX, creating a single-carrier haul with more advantaged economics. The Pan Am acquisition expands CSX's reach in Connecticut, New York and Massachusetts, while adding Vermont, New Hampshire and Maine to its existing 23-state network.[167]

The majority of propane and butane exports from Canada already move by rail as illustrated in Figure 74, so increasing rail volumes from Canada to domestic customers if necessary would be a viable option.

**Figure 74: Canada Propane and Butane Exports by Transportation Mode[168]**



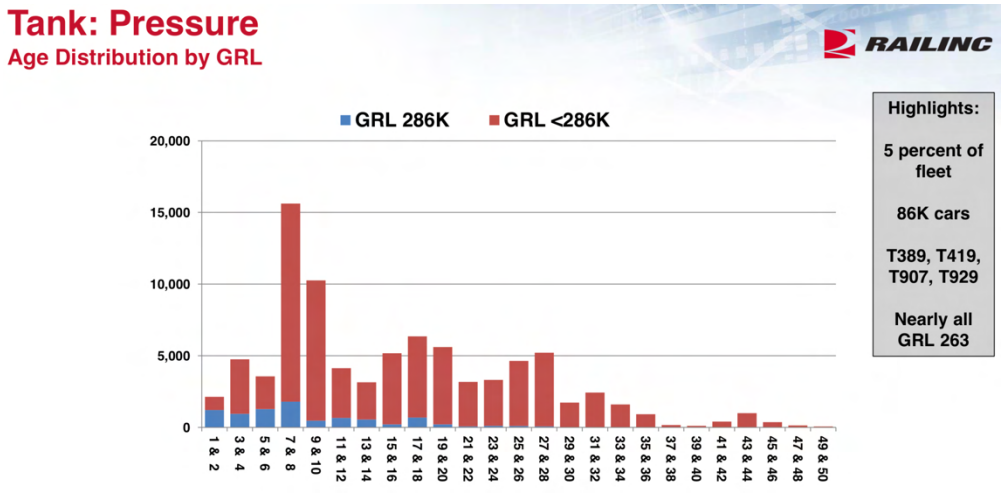

## Can enough tank cars be secured for Phase I propane-by-rail operations?

The total fleet of pressurized tank cars across all specifications in North America is about 86,000 cars (Figure 75). However, because of its light product density the ideal car size for propane is large pressure cars with a shell capacity of at least 33,000 gallons. The fleet of large pressure cars best suited for propane

[166] Railway Age, *CSX-Pan Am Merger Complete* (June 2022)
[167] Railway Age, *CSX-Pan Am Merger Complete* (June 2022)
[168] Canada Energy Regulator, *Natural Gas Liquids Pipeline Transportation System* (July 2021)

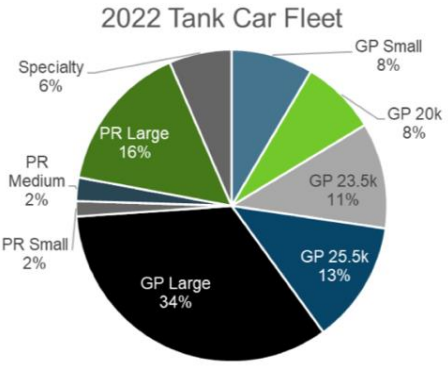
is approximately 68,313 cars of the specification DOT-105 or DOT-112 (with further sub-classifications relating to tank pressure). About 81% of this fleet of tank cars is presently in LPG service (55,334 cars).[169]

**Figure 75: North American Pressure Tank Car Fleet[170]**




As discussed earlier, if rail were to supplant the volume of NGLs presently provided by Line 5, not all of that replacement volume would necessarily still originate in western Canada, and also most of that volume is already handled via rail and the existing large pressure tank car fleet once it departs the storage caverns at Plains-Sarnia. A certain portion of the volume from Line 5 that presently transits Sarnia could ship directly from production areas to end-use customers, bypassing Sarnia-area storage altogether. Assuming that 1/3 of that future volume is able to do so, then a remaining 2/3 of that volume (about 48.5 kbpd) plus new rail volume for northern Wisconsin and the Upper Peninsula of Michigan (about 5.8 kbpd for a total of 54.3 kbpd) would represent new railcar fleet demand of approximately 2,676 cars under a conservative "farthest-distance" scenario in which all of the replacement NGLs by rail volume would continue to come from western Canada. [171] This demand would amount to approximately 3.9% of the current fleet of propane and butane-suitable large pressure tank cars.

**Figure 76: North American Tank Car Fleet[172]**




While the Phase I solutions can commence operations almost immediately, a ramp-up period of several months may be required before the full volume representing new rail activity would be attained. This would be due mainly to the assignment and redeployment of tank car equipment. However, as mentioned earlier, all of the existing market players involved in Line 5 markets and products are large and sophisticated refiners and midstream operators, including ExxonMobil/Imperial, Shell, Plains, Valero, Pembina, Suncor, Marathon, and others. All of those companies already have significant tank car fleets under their own control, and have significant leverage and buying power with tank car lessors and builders. For example, NGL Energy

[169] Integrity Rail Partners; PLG analysis of UMLER data (October 2022)
[170] Railinc, *North American Railcar Review* (March 2023)
[171] Based on PLG fleet sizing model assuming Edmonton-Sarnia via CN manifest service
[172] Integrity Rail Partners (April 2023) using UMLER data analyzing 438,880 tank cars. Pressure cars designated as "PR;" general purpose cars designated as "GP."

Partners (Ambassador Pipeline) has a fleet of 4,400 leased tank cars[173], and Plains controls a fleet of over 4,000 NGL tank cars.[174]

**Figure 77: 33,700 Gallon Pressure Tank Car[175]**


Therefore, in the event that new railcars for Line 5 alternative supply chain solutions are required, it would not involve unknown shippers having to cold-call for railcars. Rather, the market participants will be able to first examine their large existing fleets to identify equipment that can be utilized in the new service. If necessary, as a second step these players will go to the well-known vendor base of railcar builders and lessors, with whom these established market players have longstanding relationships. And, as also demonstrated earlier the current tank car backlog is relatively low as compared to prior recent historical peaks, enabling the procurement of additional pressure tank cars, if needed, within 18 months.

### Phase II Near Term (within 18 months) Alternative Supply Chain Solutions for Propane Delivery to Sarnia Area Storage Caverns and Direct-Shipment to Customers

As explained above, the Phase I immediate-term solutions to enable shipment of purity propane to Sarnia/Port Huron/Windsor storage caverns as well as direct shipment to customers and thus bypassing those storage caverns merely make use of existing rail loading and unloading racks at both production areas and storage sites, as well as the myriad propane rail distribution terminals from which the vast majority of "last mile" propane delivery already takes place. It is because all of that infrastructure already exists, and the fact that rail is already a usual and customary means of propane distribution, that these solutions can commence within just a few months.

PLG has identified a single Phase II alternative supply chain solution that also makes use of already existing infrastructure, but will require approximately 18 months for nominal investment and implementation. That solution is to **ship purity propane or a mixed NGL with propane via already existing NGL pipelines connecting the Marcellus/Utica shale play to the Sarnia/Port Huron/Windsor storage caverns.** In essence, this solution effectively replicates Line 5's service of delivering NGLs via pipeline to Sarnia, except that 1) the product from Marcellus/Utica would be purity propane rather than a mixed NGL and therefore would not require fractionation, and 2) the distance from Marcellus/Utica would be less than 1/3 of the distance as Alberta.

[173] NGL Energy Partners, *2022 Form 10-K* (May 2023)
[174] Plains All American Pipeline, *2022 Form 10-K* (March 2023)
[175] The Greenbrier Companies, *33,700 Gallon LPG Pressure Tank Car* (Retrieved October 2023)

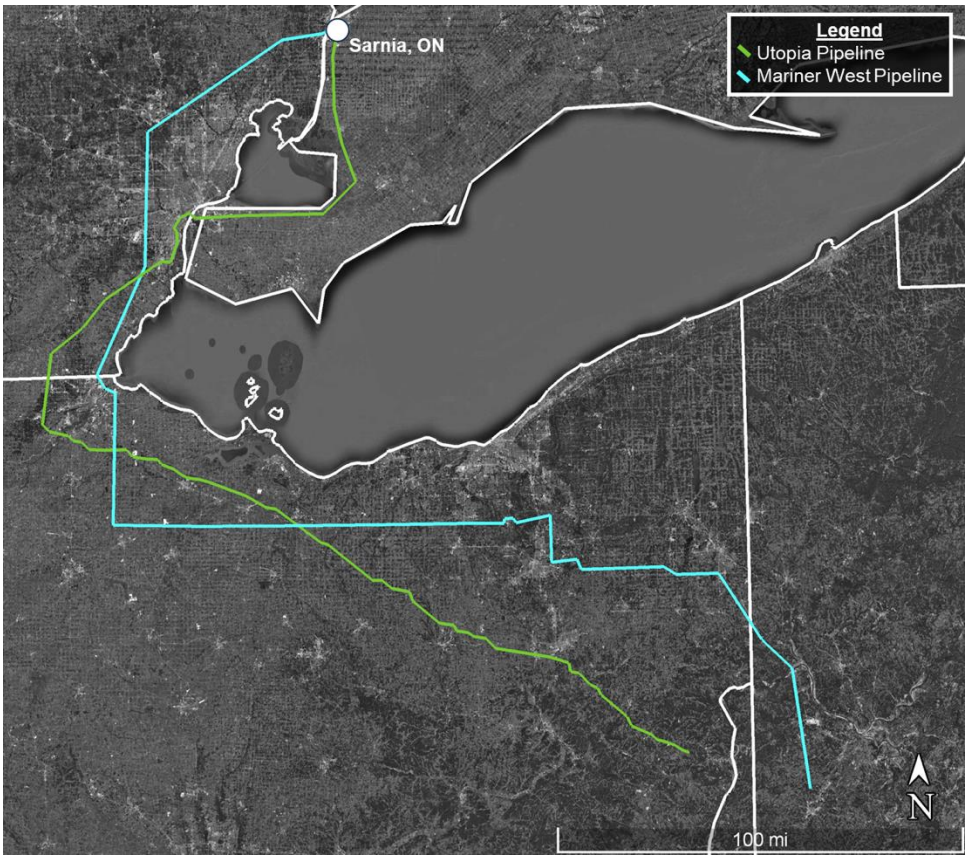
## Two NGL pipelines already connect the Marcellus/Utica shale play with Sarnia today.

There are two NGL pipelines that currently move ethane from Marcellus/Utica to Sarnia: Mariner West and Utopia. Spare capacity plus increasing capacity by adding pumping could be used to move propane in addition to the ethane demand under one of three scenarios described below.

### Overview of Mariner West and Utopia Pipelines

Mariner West is primarily an 8" NGL pipeline with a maximum diameter of 10". It is owned by Energy Transfer and has an advertised capacity of 50 kbpd of ethane[176]. Given its size, this pipeline is capable of moving 85 kbpd, likely with some pumping required. Nova is the primary committed shipper of ethane on Mariner West and has access to incentive rates. Imperial Oil is a much smaller committed shipper, with ethane demand estimated at 5-10 kbpd. The current Mariner West pipeline tariff rate for ethane deliveries from Pennsylvania points to Sarnia is $6.7941/bbl[177].

**Figure 78: NGL Pipelines from Marcellus/Utica to Sarnia[178]**




Utopia is a 12-inch NGL pipeline owned by Kinder Morgan that commenced service in 2018. It includes new pipe from Harrison County, OH to Riga, MI where it connects with existing Kinder Morgan pipeline (former Cochin Pipeline) for delivery to the Sarnia area.

The pipeline's capacity stated in its initial tariff filing was 50 kbpd, but it was advertised as expandable to 75 kbpd[179] presumably by simply adding pumps. Given the

[176] Energy Transfer, *Natural Gas Liquids (NGLs)* (Retrieved September 2023)
[177] Energy Transfer (still under its previous Sunoco Pipeline L.P. name), *F.E.R.C. No. 206.12.0 and CER Tariff No. 14.10 – Ethane from Points in Pennsylvania to Sarnia, Province of Ontario, Canada* (November 2022)
[178] EIA, PLG Analysis, Google Earth (September 2023)
[179] Kinder Morgan, *Kinder Morgan Begins Operation of the Utopia Pipeline System* (January 2018)

diameter of the pipeline and its recent vintage, with additional pumping this pipeline could move over 120 kbpd. The original plan for this pipeline route (new pipe plus existing Cochin) was 75 kbpd with expandability to 175 kbpd for Y-grade (mixed NGLs)[180]. While initially advertised as transporting ethane and ethane-propane mixtures[181], the current tariff lists only ethane. The current Utopia pipeline tariff for volumes in excess of 10 kbpd is $5.83/bbl of ethane[182].

Nova is the anchor shipper on Utopia and is believed to have a contract for at least 30 kbpd for at least 20 and possibly 30 years. Both Mariner West and Utopia deliver ethane to Nova's Sarnia chemical complex, at which a major expansion is taking place that is due to be completed in the 4th quarter of 2023. When running at full capacity, Nova's Sarnia ethane demand post-expansion could be as much as 75 kbpd. Utopia brings important benefits to Nova by diversifying its ethane feeds, plus it theoretically allows its full cracker requirements to be met from either Utopia or Mariner West should either of those pipelines experience an outage. In 2022, Utopia only moved an average of 11 kbpd and Mariner West moved 36 kbpd[183] for a total of 47 kbpd, compared to their combined current capacity of 100 kbpd (or a combined potential capacity of 205 kbpd with additional pumps). This will of course change when the Nova expansion is in commercial service.

### Three Potential Scenarios for Use of Mariner West and/or Utopia for Propane Supply to Sarnia/Port Huron/Windsor Area Storage Caverns

There are several approaches that can be taken for utilization of these pipelines to provide an alternative supply of propane in a Line 5 shutdown scenario. All of these scenarios will depend on negotiations among several parties, but each offers an affirmative business case for the stakeholders involved. These scenarios are presented in order of desirability based on complexity, capital investment, and surety of supply.

**1. Run Ethane-Propane Mix on Either or Both Pipelines**

Under this option, a de-ethanizer tower would need to be built in Sarnia. Some incremental ethane storage could be required, but not as much as the second option. This option could run primarily in the summer when moving propane into storage at Sarnia is most beneficial. In the winter, propane could move directly to end-consumer by rail from Marcellus/Utica and bypass Sarnia. A de-ethanizer capable of processing a mixture of 80 kbpd of ethane and 50 kbpd of propane is estimated at $35 - $80 million of capital expense including installation. Companies with de-ethanizers typically charge around 3 cents per gallon.

**2. Run Propane Batches Along with Ethane Batches on Either or Both Pipelines**

Another pipeline option would be to run batches of propane on either or both pipelines in addition to current ethane so as long as contractual commitments could be met. As an example, Utopia could add 35 kbpd or 80 kbpd of propane at pipeline capacities of 75 kbpd or 120 kbpd, respectfully, assuming 40 kbpd

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[180] Oil & Gas Journal, *Kinder Morgan announces westbound Marcellus NGL pipeline* (April 2010)
[181] Kinder Morgan, *2017 Form 10-K* (February 2018)
[182] Kinder Morgan Utopia, *FERC No. 7.1.0 – International Joint Volume Incentive Rate Tariff Applying on Purity Ethane from An Origin Point in the State of Ohio to A Delivery Point in the Province of Ontario* (May 2023)
[183] FERC, *Sunoco Pipeline L.P. (former name of Energy Transfer) – FERC Form No. 6: Annual Report of Oil Pipeline Companies* (March 2023); "Total Delivered Out" in Michigan of "Other including Transmix-29119"; other two categories for Michigan are Gasoline/Jet Fuel -29111 and Distillate Fuel Oil-29113 which are not ethane-related

is contracted to Nova. This option would be much more capital intensive because 1-2 days of ethane storage could be required at both the supply point (fractionators) and at the delivery point (Sarnia) so that both the local fractionators and the ethane cracker could remain in continuous operation. This option could run primarily in the summer when moving propane into storage at Sarnia is most beneficial. In the winter, propane could move directly to end-consumer by rail from Marcellus/Utica and bypass Sarnia.

**3. Convert One Pipeline to Exclusively Propane**

Since either pipeline could theoretically move all of the ethane needed for Sarnia, the other pipeline could be used to deliver even more purity propane than the Sarnia fractionator is currently producing. In order for this to happen, Nova, Imperial and the pipeline companies would need to renegotiate existing contracts. The pipeline companies would be incentivized to adjust their contracts with Nova and Imperial as this would generate substantial incremental revenue. If they could stay in service dedicated to a single product, e.g., ethane or propane, they should be able to add volumes for relatively little capital expense. To incent Nova to agree to a revised agreement, their rate may need to be adjusted as well as some protections given to insure reliable service to the ethane crackers. It is possible some incremental ethane storage would be needed.

### Summary of Phase I and Phase II Alternative Supply Chain Solutions for NGLs

With the ability to commence new rail-based supply chain solutions within three months, plus additional propane rail terminal and pipeline-based alternatives within 18 months, commercially viable and operationally feasible solutions are at hand for Line 5 NGL products and markets in the event of a shutdown. As emphasized earlier, energy supply chains are dynamic and constantly evolving to changing markets and conditions.

In the case of NGLs, potential combinations of supply sources, modes, and other variables are so numerous that it is difficult to reliably project the cost implications for the retail price of propane for affected markets. Those difficult to predict variables include but are not limited to:

- The percentage of former Line 5 volume that would go rail-direct to customers during wintertime, bypassing Sarnia
- The percentage of current Line 5 volume handled by the five storage caverns in the Sarnia region that would be delivered via rail to those storage caverns during the summer inventory build season
- How much the west coast export demand volume for Western Canada propane will continue to grow, and potentially eroding the historical price discount for Edmonton supplies
- The degree to which Conway, KS, Morris, IL, Mont Belvieu, and Marcellus/Utica supply becomes more competitive with Edmonton supply
- Asian and European demand for British Columbia and Marcus Hook exports, respectively
- How the mix of inbound rail activity to Sarnia storage would change among potential supply sources of western Canada, the Marcellus/Utica, and other options
- If pursued, the pipeline option that is selected for delivery of Marcellus/Utica supply to Sarnia.

Even beyond pure logistics questions there are factors such as the domestic supply/demand picture plus export optionality that has exposed the domestic price of propane to international prices and markets. And, for western Canada, propane production continues to grow in concert with crude oil production, making it necessary to find a home for an increasing volume of NGLs. Lastly, persistent variables such as seasonality, severity of winter seasons, and inventory levels also affect propane costs. Thus, the retail

price of propane depends on all of these factors working in combination, rather than just solely being a question of logistics and modes in a particular corridor.

However, it is reasonable to expect that although a potential Line 5 shutdown may result in additional costs for supply of propane,

- the abundance of supply and source options,
- the ability to use existing means of transportation and logistics that already handle propane today, and
- prior industry experience with comparable supply chain alterations such as the case of the Cochin Pipeline,

indicate that such increases would be nominal and not adversely affect the relative affordability of propane consumed within the Line 5 service area in the event of a shutdown. For example, a potential 5-15 cents per gallon increase due to changes in logistics added to retail propane prices that can typically range from $2.00-$4.00 per gallon in the Northeast US would be considered a nominal increase that would likely be outweighed by other price drivers mentioned above such as supply and demand, competing international prices, and inventory levels.

## SUMMARY

Taken together, it is clear that there exists a range of commercially feasible and operationally viable solutions that can provide for alternative crude and NGL supply chains to affected markets in the event of a Line 5 shutdown. That such myriad options exist and can be readily implemented is consistent with the nature of hydrocarbon supply chains in North America, of which Line 5 products and markets are a part.

# V. APPENDIX

## Abbreviations

| | |
|---|---|
| bbls | Barrels |
| bpd | Barrels per day |
| C1 | Methane |
| C2 | Ethane |
| C3 | Propane |
| C4 | Butane |
| C5 | Pentane |
| CAPP | Canadian Association of Petroleum Producers – a trade association representing Canada's upstream oil and gas industry |
| CER | Canada Energy Regulator |
| CN | Canadian National Railway |
| CP | Canadian Pacific Railway |
| CSX | CSX Transportation |
| DOE | Department of Energy – a US government agency responsible for energy policy and resources |
| DWT | Deadweight tons |
| EIA | Energy Information Administration – an independent agency within the U.S. Department of Energy that develops survey, collects energy data, and analyzes and models energy issues |
| ET | Energy Transfer |
| EV | Electric vehicle |
| FOB | "Free On Board" - One of the 11 e Incoterms that are individual rules issued by the International Chamber of Commerce (ICC) which define the responsibilities of sellers and buyers for the sale of goods in international transactions. FOB is a widely-used agreement between a buyer and seller that the cost of goods sold includes delivery to a specific port where ownership of the goods transfers from the seller to the buyer. In other words, once the goods are placed at the specified port on the ship and "on board," any risk of damage or loss shifts from the seller to the buyer. |
| HGL | Hydrocarbon Gas Liquid, includes natural gas liquids and olefins |
| kbpd | Thousand barrels per day |
| LNG | Liquified natural gas – natural gas that has been cooled to a liquid state for storage and transportation |
| LR1 | Long Range 1 – a classification of oil tankers based on their size and capacity |
| MPSC | Michigan Public Service Commission |
| MT | Metric tons |
| NEB | National Energy Board – a Canadian regulatory agency overseeing energy-related matters |
| NGL | Natural Gas Liquid |
| NS | Norfolk Southern Corporation (Railway) |
| OPEC | Organization of the Petroleum Exporting Countries – a group of oil-producing nations coordinating oil production and pricing |
| PADD | Petroleum Administration for Defense Districts – US regions used for energy data and planning used by the Energy Information Administration |
| PMPL | Portland Montreal Pipe Line |
| STB | Surface Transportation Board – a US government agency overseeing railroad and surface transportation matters |
| USGC | US Gulf Coast |

# Glossary of Terms

| | |
|---|---|
| Aframax Tanker | Medium-sized vessel used for shipping crude oil and petroleum products, typically with a capacity of 80,000 to 120,000 deadweight tons |
| Ambassador Pipeline | Two-way pipeline connecting Kalkaska, MI to Sarnia, ON, used for transporting refined petroleum products |
| Apportionment Policy | Guides the allocation of pipeline capacity when demand exceed available space |
| Apportionment Rules | Specific procedures for fairly distributing pipeline capacity among shippers during constraints |
| Bakken Shale | Prolific shale formation in North Dakota, Montana, Saskatchewan, and Manitoba, known for significant oil and gas reserves |
| Bluewater Access | Maritime entry points or routes for shipping that enable ocean-going transit, inclusive of the Great Lakes |
| Brownfield Site | Property previously developed for industrial use |
| Butane | Hydrocarbon gas used as fuel, propellant, or petrochemical feedstock |
| Capacity | Maximum amount of substance a facility or route can handle within a specific timeframe |
| Capital Cost | Total expenses incurred in planning, constructing, and commissioning an infrastructure project |
| Cargo Capacity | Maximum amount of goods or materials a vessel, vehicle, or container can transport |
| Chemical Feedstock | Raw material used in industrial processes to produce chemicals or products |
| Clean Products | Refined petroleum products, such as gasoline and diesel, that meet strict environmental standards for emissions |
| Coiled Railcar | Specialized railcar equipped with heating coils to transport temperature-sensitive liquids, like chemicals |
| Condensate | Light liquid hydrocarbon mixture often found alongside natural gas and crude oil, used as feedstock or blended with crude oil as a diluent |
| Crude Oil | Natural resource extracted from the ground, comprising hydrocarbons, used as a primary source for producing various fuels and products |
| Crude-by-Rail | Transportation of crude oil via railcars, an alternative to pipelines for moving oil from production sites to refineries |
| Depropanization | Process that removes propane from a mixture, often used in natural gas processing |
| Diluent | Substance added to a liquid or mixture to make it thinner or less concentrated or reduce viscosity |
| Dirty Products | Unrefined or less refined petroleum products, such as heavy crude oil or residual fuel oil |
| Distillation | Separation process that involves heating a liquid mixture to separate its components based on their boiling points |
| Dry Natural Gas | Natural gas that primarily consists of methane and contains minimal impurities or natural gas liquids |
| Eagle Ford Shale Play | Significant shale oil and gas producing region located in South Texas, USA |
| Eastern Canadian Provinces | Refers to provinces in eastern Canada, including Ontario, Quebec, New Brunswick, and Newfoundland |
| Economies of Scale | Cost advantages gained when production or service volume increases, typically resulting in lower average costs |
| Electric Vehicles | Automobiles powered by electricity stored in rechargeable batteries |
| Enbridge Mainline | A major crude oil pipeline system operated by Enbridge Inc., transporting oil from Western Canada to the central US and connections with other pipelines |
| End-use Customers | Final consumers or businesses that directly utilize products or services for their intended purposes |
| Ethane | Hydrocarbon gas often used a feedstock in the petrochemical industry |

| | |
|---|---|
| Export Capacity | Maximum quantity of goods, products, or commodities that can be shipped or sold to international markets |
| Fixed Racks | Permanent structures used for loading/unloading of goods or materials, often found in industrial facilities |
| Fixed Rail Facilities | Facilities equipped with permanent infrastructure for the handling, staging, storage and transport of goods via rail, typically used for loading and unloading purposes |
| Flow Capacity | Maximum volume or rate of fluid, gas, or material through a pipeline, system, or container can handle within a given time period |
| Flow Rate | Rate at which a fluid or substance moves through a pipeline, channel, or system, typically measured in volume per unit of time |
| Fossil Fuels | Non-renewable energy sources derived from ancient organic materials, including coal, oil, and natural gas |
| Fractionation | Process of separating a mixture of substances into its individual components based on their differing boiling points or other physical properties |
| Fractionation Towers | Tall vertical columns used in the fractionation process to separate various components of a mixed substance by vaporizing and condensing them at different heights |
| Freight Rate | Price or charge for the transportation of goods via various modes, typically based on factors like distance and cargo type |
| Fuel Terminal | A facility or location where fuels, such as gasoline, diesel, or jet fuel, are stored, distributed, and often loaded onto trucks or transported via pipelines or other means |
| Greenfield Land | Untouched or undeveloped land that has not been previously built upon or used for industrial or commercial purposes |
| Horizontal Drilling | A drilling technique used in the oil and gas industry where a well is drilled horizontally into underground reservoirs, allowing for increased access to hydrocarbon deposits |
| Hydraulic Fracturing | A process in which fluid is injected into underground rock formations at high pressure to create fractures and release hydrocarbons such as natural gas or oil |
| Hydrocarbon Gas Liquids | Refers to both the natural gas liquids (paraffins or alkanes including ethane, propane, butanes, and pentane) and olefins (alkenes including ethylene, propylene, butylene, and isobutylene) produced by natural gas processing plants, fractionators, crude oil refineries, and condensate splitters but excludes liquefied natural gas (LNG) and aromatics |
| Hydrocarbons | Organic compounds composed of hydrogen and carbon atoms, often found in fossil fuels like oil and natural gas |
| Ice Class Vessels | Ships or vessels designed and constructed to navigate in icy or polar regions, typically equipped with reinforced hulls and other features to withstand ice conditions |
| Injection Point | A location or facility where substances, such as chemicals or fluids, are introduced into a system, reservoir, or pipeline, often for the purpose of enhanced oil recovery or other processes |
| Insulated Railcar | Railcar equipped with insulation to maintain specific temperatures for cargo, often used for transporting temperature-sensitive materials |
| Isobutane | Hydrocarbon gas used as a fuel and a feedstock in various industrial processes, known for its chemical stability and flammable properties |
| Jacketed Tank Car | Specialized railcar designed with an outer layer for thermal insulation and protection, often used for transporting temperature-sensitive materials |
| Lakehead System | A network of Enbridge pipelines and facilities in the Great Lakes region, including Line 5, that transport crude oil and other products |
| Light Sweet Crude Oil | A type of crude oil known for its low sulfur content and specific gravity |
| Line 5 | A specific pipeline operated by Enbridge, running from Superior, WI to Sarnia, ON, and transporting crude oil and mixed NGLs |
| Linehaul Transportation Capacity | Maximum volume or capacity of a transportation system, such as a pipeline or railway, for moving goods over long distances |

| | |
|---|---|
| Loading Capacity | Maximum amount of cargo that a specific facility or transportation mode can load onto a vehicle or vessel |
| Loadout Requirement | Specific conditions, criteria, or procedures for loading cargo onto transportation vehicles or vessels |
| Marcellus Shale Play | Geological formation located in the northeastern United States, production primarily in Pennsylvania, New York, and West Virginia. Rich in natural gas reserves and a key area for shale gas production. Overlaps the Utica Shale Play so often referenced together. |
| Mariner East Pipeline System | Network of pipelines to transport natural gas liquids (NGLs), including propane, ethane, and butane, from the Marcellus and Utica Shale fields to markets in Pennsylvania and beyond |
| Methane | Hydrocarbon gas and primary component of natural gas, used as a source of energy and fuel |
| Mid-Continent Crude Oil Pipeline Network | A system of pipelines in the central United States designed to transport crude oil from production areas to refineries and markets |
| Mid-Valley Pipeline | A crude oil pipeline that originates in Longview, TX terminates in Michigan near the Marathon Detroit, MI refinery to a pipeline that connects to the refinery. The pipeline also delivers crude oil to Toledo refineries. Crude oil from Cushing, OK and Bakken can connect with Mid-Valley Pipeline in Lima, OH among other storage locations along the pipeline. |
| Mixed NGL Stream | A combination of natural gas liquids (NGLs), that may including propane, butane, and ethane, typically produced together as a mixture during natural gas processing |
| Natural Gas | Fossil fuel composed primarily of methane, often used as a source of energy for heating, electricity generation, and various industrial processes |
| Natural Gas Liquids | Hydrocarbons often found in natural gas, including ethane, propane, and butane, typically extracted and used as valuable resources |
| Natural Gasoline | Liquid hydrocarbon mixture extracted from natural gas production and used as a feedstock in the petrochemical industry |
| Network Optimization Analysis | A computational process used to find the most efficient and cost-effective way to allocate resources or route products within a complex system, such as a supply chain or transportation network |
| Offloading Facility | Specialized location for unloading cargo from transportation vehicles or vessels, ensuring safe and efficient transfer of goods |
| Oil Tankers | Large ships designed for transporting crude oil, petroleum products, or other liquid cargoes across oceans and navigable waterways |
| Over-the-Fence Pipeline | A pipeline that extends beyond a facility's property line to an adjacent property, allowing the transportation of materials or products between different industrial facilities or companies but which is not buried underground |
| Pan Am Railways | Transportation company that operates a network of railroads primarily in the northeastern United States; sold to CSX in 2023 |
| Panamax Tanker | Type of ship designed to maximize its cargo capacity while fitting within the dimensions of the Panama Canal |
| Payback Period | Financial metric that represents the amount of time it takes to recover the initial investment or cost of a project through its generated cash flows or savings |
| Permian Basin | A prolific oil and natural gas producing region located in West Texas and southeastern New Mexico in the United States |
| Pipeline Capacity | Maximum volume of liquid or gas that a pipeline can transport over a given period |
| Pipeline Corridor | Designated route or pathway where pipelines are installed to transport oil, gas, or other fluids, often following a specific geographic or environmental path |
| Pipeline Reversal | Process of changing the direction of flow in a pipeline, allowing it to transport products from one location to another in the opposite direction |
| Pressure Tank Car | Specialized railcar designated to safely transport pressurized gases or liquids, such as propane, at specified pressure levels |

| | |
|---|---|
| Propane | Hydrocarbon gas commonly used as a fuel for heating, cooking, and various industrial applications |
| Purity Products | Refined and processed materials, such as propane and butane, that have been separated and purified from mixed NGL streams or other raw hydrocarbon sources for specific uses |
| Rail Distribution Terminal | Facility equipped to handle the offloading, storage, and loading of goods, often situated along railway lines to facilitate the transfer of cargo between trains and other transportation modes |
| Rail Linehaul Services | Long-distance transportation of goods by rail, typically involving the movement of freight over extended distances between major rail terminals |
| Rail Loadout Capacity | Maximum volume or rate at which goods can be loaded onto railcars at a particular facility, ensuring efficient transfer and transportation by rail |
| Railcar Equipment | Various railcars designed to transport specific types of cargo, such as pressure tank cars for propane or general purpose tank cars for crude oil |
| Refined Petroleum Products | Processed hydrocarbons derived from crude oil through refining processes, including gasoline, diesel fuel, jet fuel, and other finished products |
| Refinery | Industrial facility where crude oil is processed and transformed into various refined petroleum products, involving distillation, cracking, and other refining processes |
| Refining District | US regions used by the Energy Information Administration for reporting data on refinery and other hydrocarbon processors (like fractionators) |
| Shale Development | Exploration and extraction of natural gas and oil from shale rock formations, often utilizing technologies like hydraulic fracturing and horizontal drilling to access hydrocarbon resources |
| Shale Oil-Producing Areas | Regions known for significant shale oil production, such as the Eagle Ford, Bakken, and Permian basins |
| Single-Line Haul | Transportation scenario where freight is moved via rail using just one rail carrier |
| Steam-assisted Gravity Discharge | Method employed to extract crude oil from the Oil Sands region of western Canada |
| Storage Hub | Strategically located facility designed for the temporary storage of various commodities or goods, often serving as a distribution point or transit center within a broader supply chain network |
| Suezmax Tanker | Type of oil tanker with dimensions optimized to traverse the Suez Canal |
| Supply Chain | Entire sequence of activities, processes, and entities involved in the production, transportation, distribution, and delivery of goods or services from suppliers to end-use customers, including the flow of materials, information, and finances |
| Takeaway Capacity | Maximum volume of oil, natural gas, or other commodities that can be transported from a production area or terminal to its destination, typically through pipelines, railroads, or other transportation means |
| Tank Car Builder | Company or manufacturer specializing in the construction and assembly of tank cars, which are specialized railcars designed for the transportation of liquids or gases |
| Tank Car Fleet | Collection of tank cars owned or operated by a single entity, such as a transportation company or industrial firm, for the purpose of shipping and storing various liquid or gaseous commodities |
| Tank Car Lessor | Entity or company that owns tank cars and leases them to other businesses or organizations for the transportation of liquids or gases |
| Tank Storage Capacity | Maximum volume of liquids or gases that can be held within storage tanks, typically at facilities such as refineries, terminals, or distribution centers |
| Tariff | Published schedule of rates, charges, or fees established by a transportation company, pipeline operator, or other service provider for the use of its services, including transportation or storage |

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| Terminaling | Activities related to the operation, management, and handling of goods, particularly the loading, unloading, storage, and distribution of commodities at transportation terminals or facilities |
| Throughput | Total volume of goods, commodities, or materials that pass through a specific point, facility, or system within a given period, often used to measure the efficiency and capacity of transportation or processing operations |
| Throughput Revenue | Income generated by a transportation or processing facility based on the volume of goods or commodities passing through it, typically through fees, charges, or tariffs |
| Total Landed Cost | Comprehensive cost associated with acquiring, transporting, and delivering a product or commodity to its final destination, considering all expenses from production to delivery |
| Transload Facility | Location equipped for transferring goods between transportation modes, i.e. railcars to trucks, for efficient distribution |
| Transloading | Process of transferring goods between transportation modes, often at a specialized facility |
| Truck Unloading Racks | Structures for safely transferring liquids or gases from tank trucks to storage facilities |
| Twinning | Building a new pipeline alongside an existing one, often within the same right-of-way or conduit, to increase transportation capacity |
| Unfractionated NGLs | Mixture of hydrocarbons that has not undergone fractionation |
| Unit Train | Train carrying a single commodity that moves intact from its point of origin and/or to its point of destination |
| Utica Shale Play | Geological formation and area of significant natural gas and oil production, production primarily from Ohio, West Virginia, and Pennsylvania. Overlaps the Marcellus Shale Play so often referenced together. |
| Utopia Pipeline | A pipeline system owned by Kinder Morgan that transports NGLs from Ohio to Windsor, ON |
| Vapor Pressure | Pressure from vapors above a liquid, used for safety assessment |
| Waterborne Deliveries | Goods transported via water bodies using vessels |
| Waterborne Imports | Imported goods shipped by water |

## About PLG Consulting

**PLG Consulting** (www.plgconsulting.com) provides consulting and management services in strategy, supply chain, and logistics engineering focused on the industrial economy. Founded in 2001, PLG delivers objective, expert consulting services for shippers, transportation companies, financial firms, government entities, investors, and other stakeholders in the world of commodity supply chain and logistics. With a team of over 40 industry veteran consultants, PLG serves over 300 clients in the energy, renewables, chemicals, minerals, bulk commodities, private equity, and surface transportation sectors.

Within core verticals that include oil and gas and all surface transportation modes, PLG has been engaged in over 100 projects relating to energy logistics since the advent of the "shale revolution" in 2010. Those projects relating to the subject matter of hydrocarbon supply chains have been performed on behalf of the full range of industry participants and stakeholders therein, including upstream exploration and production firms, midstream operators, refiners; railroad, truck, barge, and pipeline companies; trade associations, bulk liquid terminal operators, railcar builders and lessors, banks, government agencies, hedge funds, traders, and private equity firms. PLG's representative project experience in the area of hydrocarbon energy logistics includes but is not limited to:

- Supply chain design and implementation
- Rate negotiations

- Logistics infrastructure design & engineering
- Loading and unloading facility planning and operations
- Tank car acquisition, mechanical specification, and pre-delivery inspection
- Volume and railcar demand forecasts
- Commodity flow analysis
- Operational and commercial due diligence on terminals, carriers, and assets.

The firm's relevant articles, presentations, and speaking engagements include:

- *"Inflation Update: Energy & Industrial Commodities," June, 2023*
- *"Trends in Energy & Basic Materials," Rail Equipment Finance Conference, La Quinta, CA, March 2022*
- *"Energy & Materials in the Age of Decarbonization: Implications for Rail," Rail Equipment Finance Conference, La Quinta, CA, March 2022*
- *"Navigating in a Volatile World: Chemicals, Plastics, & Polymers Pricing and Supply Trends," AWA Global Release Liner Conference & Exhibition, Chicago, IL, November 2021*
- *"Reshaping the Chain: Supply Chain Update," Southwest Association of Rail Shippers Annual Meeting, San Antonio, TX, March 2021*
- *"Capturing a Decade of Opportunity: Anticipating and Understanding Supply Chain Evolutions," Railroad Financial Corporation virtual presentation, March 2021*
- *"North American Energy Update: Opportunities and Challenges for Rail in Upstream, Refining, Chemicals and Renewables," Rail Equipment Finance Conference, La Quinta, CA, March 2020*
- *"Updated: From Upstream to Downstream: Opportunities and Challenges for Rail," North American Rail Shippers Association Annual Meeting, San Antonio, TX, May 2019*
- *"Crude-by-Rail and Refined Products Transport Infrastructure," Bank of America Merrill Lynch 2019 Transportation and Industrials Conference, Boston, MA, May 2019*
- *"From Upstream to Downstream: Opportunities and Challenges for Rail," Rail Equipment Finance Conference, La Quinta, CA, March 2019*
- *"From Drilling to Downstream: Opportunities and Challenges for Rail," Rail Equipment Finance Conference, La Quinta, CA March 2018*
- *"The Future Has Arrived: Petrochemicals and Energy by Rail," Southwest Association of Rail Shippers, San Antonio, TX, February 2018*
- *"North American Energy Insights," North American Rail Shippers Association annual meeting, San Francisco, CA, May 2017*
- *"North American Energy Revolution: Rail Impacts Downshifting to Downstream," Rail Equipment Finance Conference, La Quinta, CA, March 2017*
- *"The Changing Energy Landscape: Implications for Rail," Rail Equipment Finance Conference, La Quinta, CA, March 2016*
- *"The Changing Landscape for Energy: Shale Oil & Gas Outlook," Southwest Association of Rail Shippers, Dallas, TX, October 2015*
- *"The North America Energy Revolution: Implications for Rail," The Rail Summit – Supply Chain Conference, Chicago, IL, April 2015*
- *"The North America Energy Revolution: Implications for Rail," Rail Equipment Finance Conference, La Quinta, CA, March 2015 and Union League Club, Chicago, IL, February 2015*

- *"Moving Crude Oil by Rail," Transportation Research Board 94th Annual Meeting, Washington, D.C., January 2015*
- *"Shale Development: The Evolving Transportation Impacts," The Rail Summit, Chicago, IL, June 2014*
- *"Shale Development: The Evolving Transportation Impacts," Rail Equipment Finance Conference, La Quinta, CA, March 2014*
- *"Crude by Rail Report," Stifel Capital Markets conference call, December 2013*
- *"Crude by Rail Report," Rail Trends conference, New York, NY, November 2013*
- *"Oil & Natural Gas: The Evolving Freight Transportation Impacts," CIT Rail Resources Conference, Jackson Hole, WY, July 2013*
- *"Oil & Natural Gas: The Evolving Freight Transportation Impacts," GE Capital – Q3 All Employee Meeting, Chicago, IL, July 2013*
- *"Oil & Natural Gas: The Evolving Freight Transportation Impacts," Midwest Association of Rail Shippers, Lake Geneva, WI, July 2013*
- *"Oil & Natural Gas: The Evolving Freight Transportation Impacts," FTR State of Freight Summit, Chicago, IL, May 2013*
- *"Shale Development in Argentina: The Evolving Supply Chain," Frac Supply Chain Summit, Buenos Aires, Argentina, April 2013*
- *"Oil & Natural Gas: The Evolving Freight Transportation Impacts," Rail Equipment Finance Conference, La Quinta, CA, March 2013*
- *"Oil & Natural Gas: The Evolving Freight Transportation Impacts," Northwestern University Transportation Center – Business Advisory Committee Meeting, Evanston, IL, October 2012*
- *"Mapping the Current Proppants Transportation Infrastructure," Proppants Summit, Denver, CO, July 2012*