

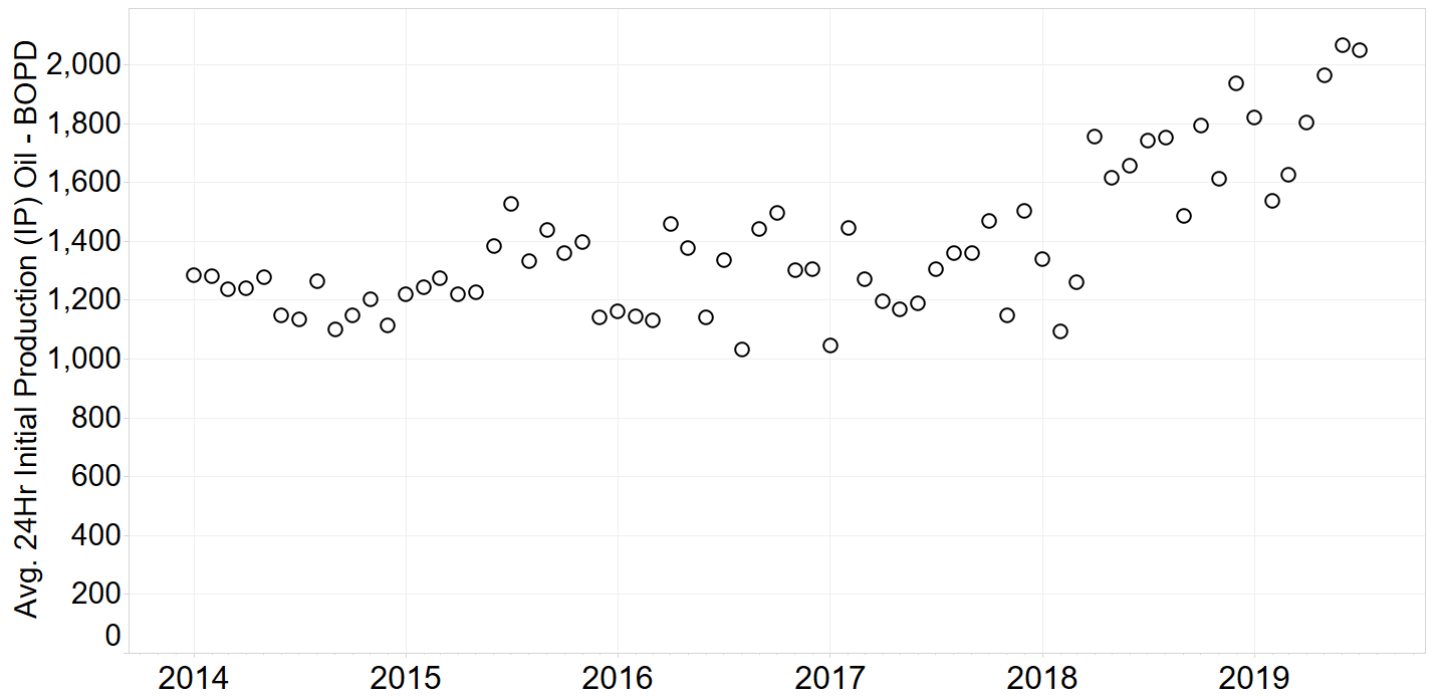
ND Oil & Gas Research Council Midstream Update

Justin J. Kringstad
Geological Engineer
Director
North Dakota Pipeline Authority

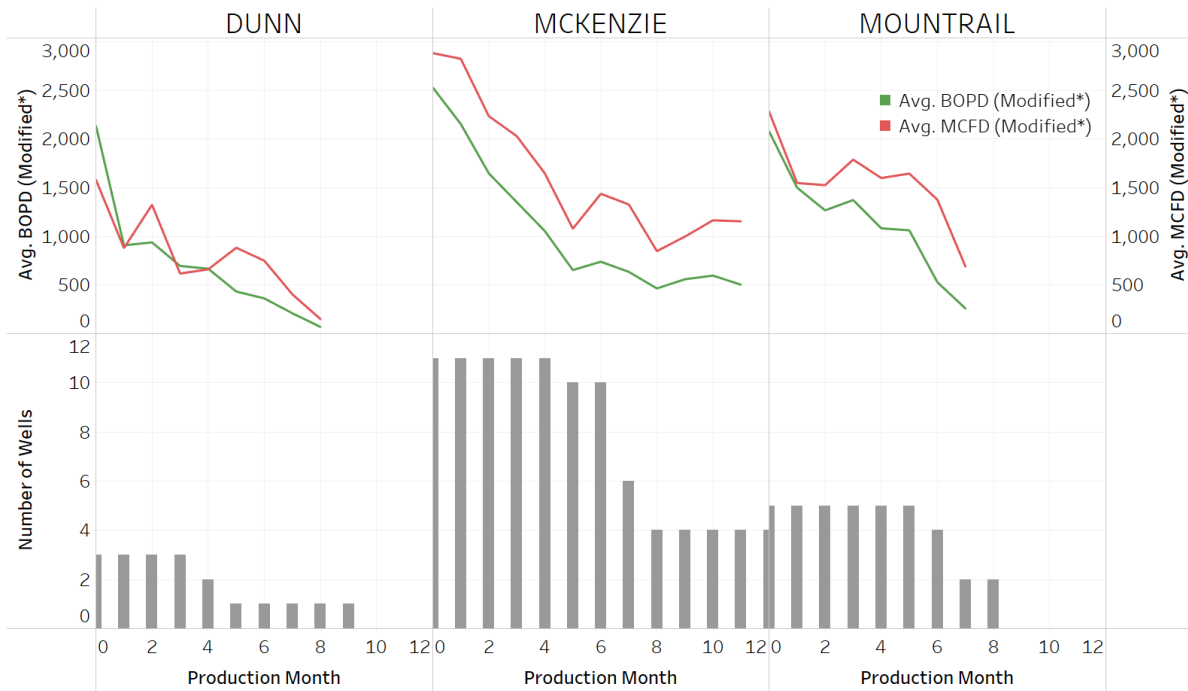
October 14, 2019



Statewide Initial Oil Production Rates – 24hr



Top 20 IP Rates (Oil)

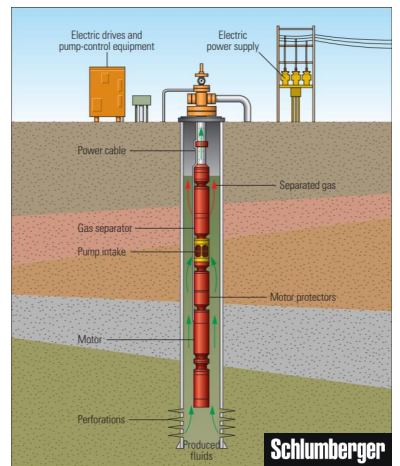


*Month "0" is a partial month with daily production calculated using "Days on production". Months 1+ use calendar days to calculate daily rate.



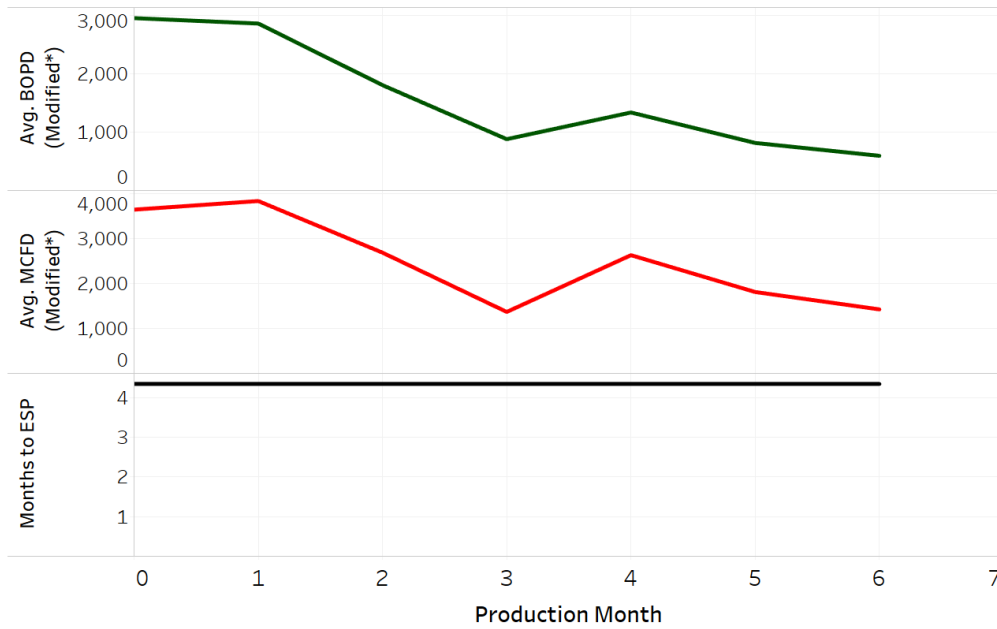
Top 20 IP Rates (Oil)

Electrical Submersible Pump (ESP) Timeline



Impact of ESP on Production Profiles

Well: SIBYL USA 44-19TFH (Mountrail County)



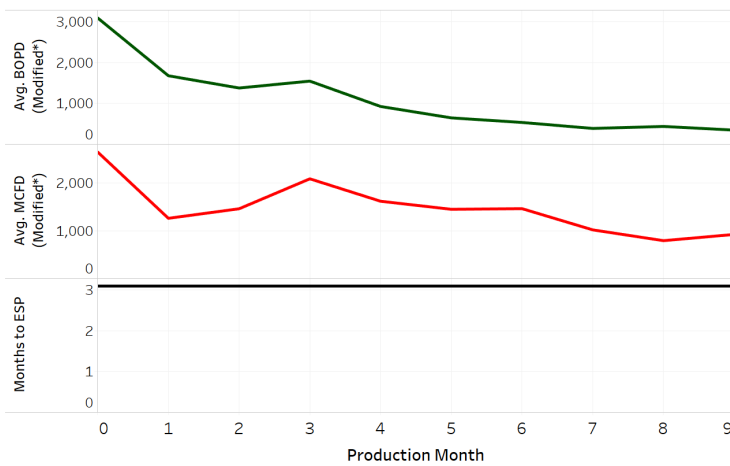
*Month "0" is a partial month with daily production calculated using "Days on production". Months 1+ use calendar days to calculate daily rate.



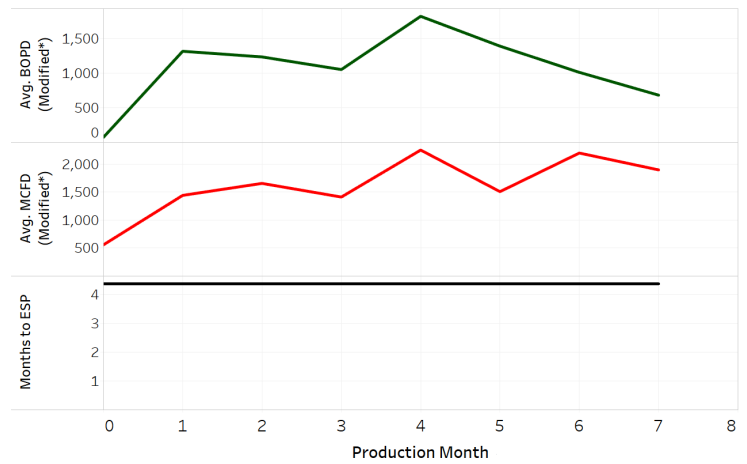
Impact of ESP on Production Profiles

Additional Examples

Well File: 32012



Well File: 33942

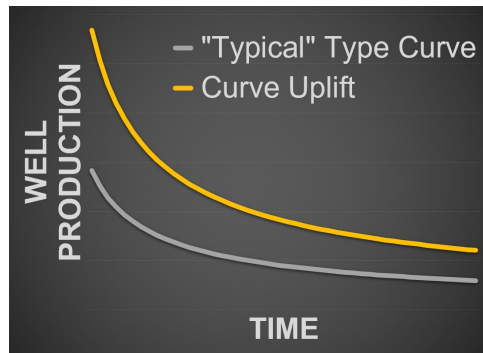
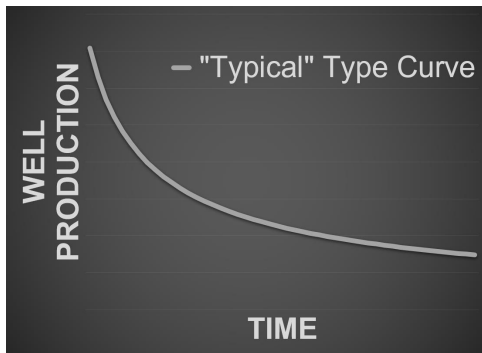


*Month "0" is a partial month with daily production calculated using "Days on production". Months 1+ use calendar days to calculate daily rate.



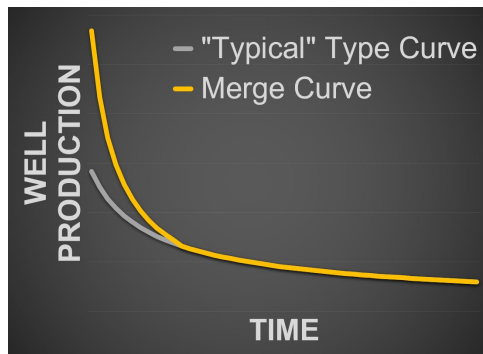
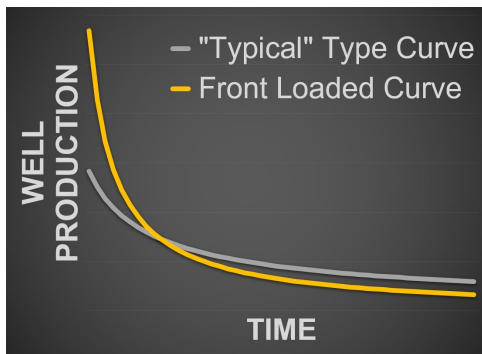
High Initial Production (IP) Scenarios

"Typical" type curve used as a comparison example for how high IP wells may perform over time.



In this example, the entire production curve over time is uplifted relative to a "typical" well. Well economics and EUR are both improved.

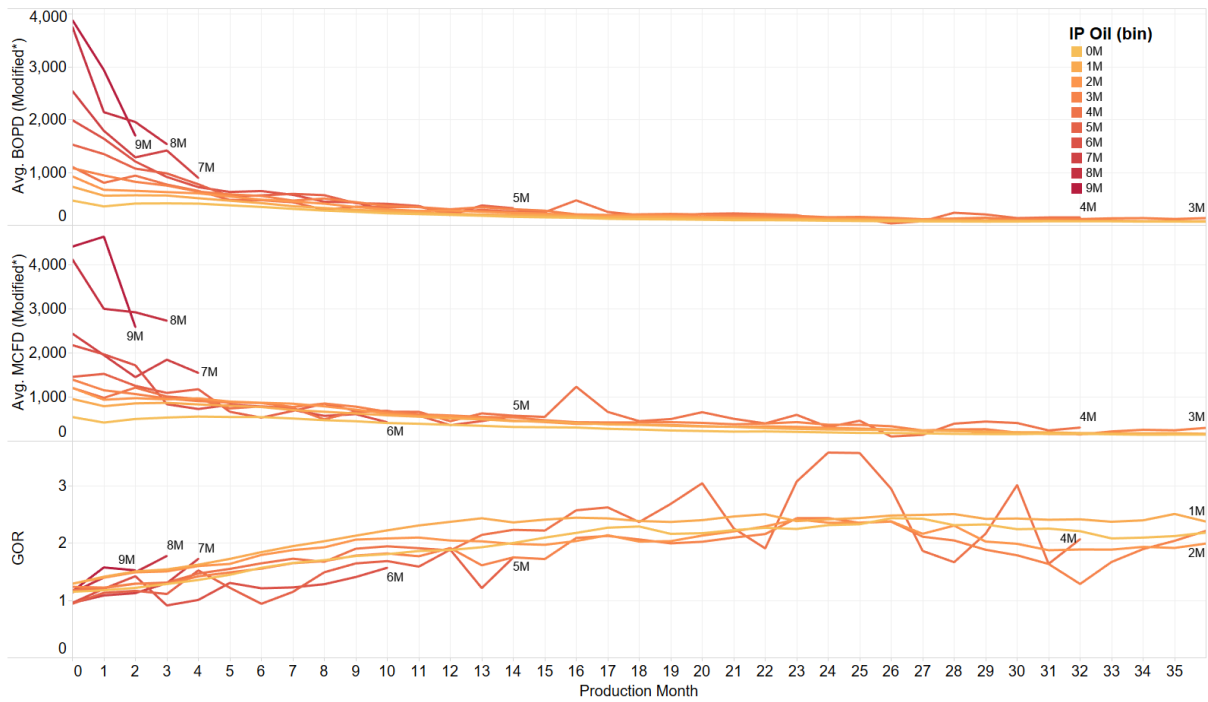
In this example, only the early life of the well is higher relative to a "typical" well. Early well economics improve, but uncertainty exists if EUR will improve or suffer with the high IP rate.



In this example, the early life of the well is higher relative to a "typical" well. Early well economics improve along with an incremental EUR improvement.



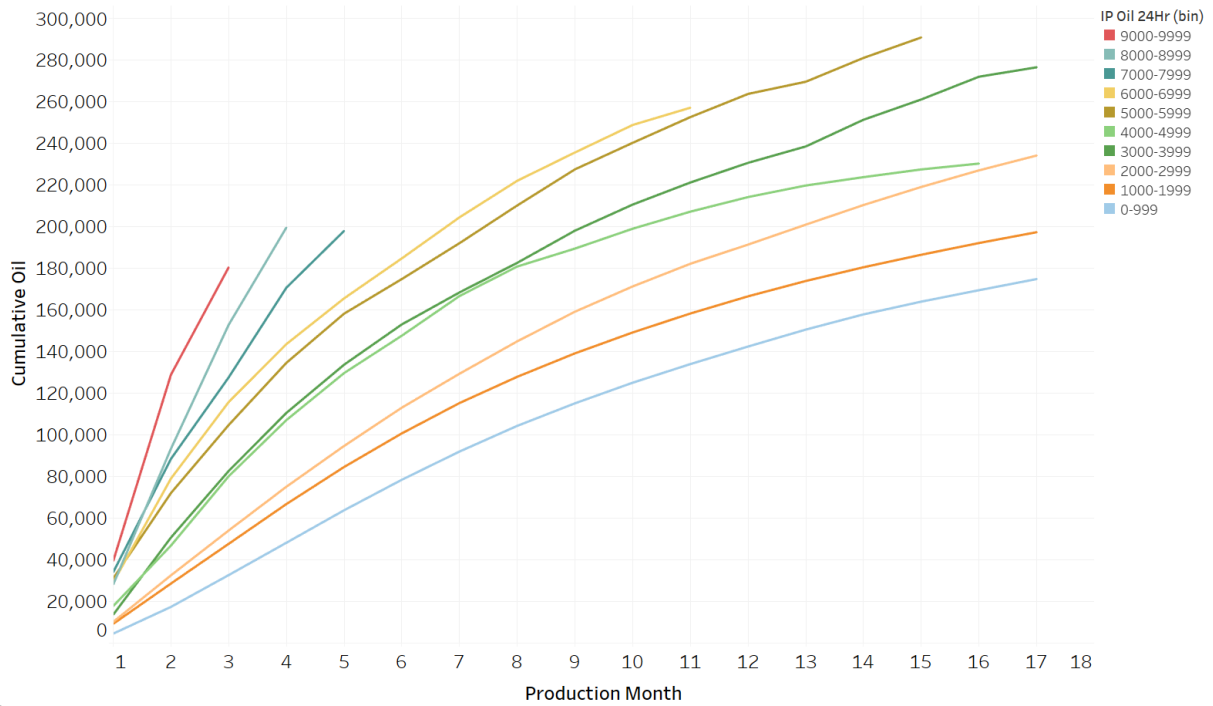
Oil/Gas IP Bin Comparison



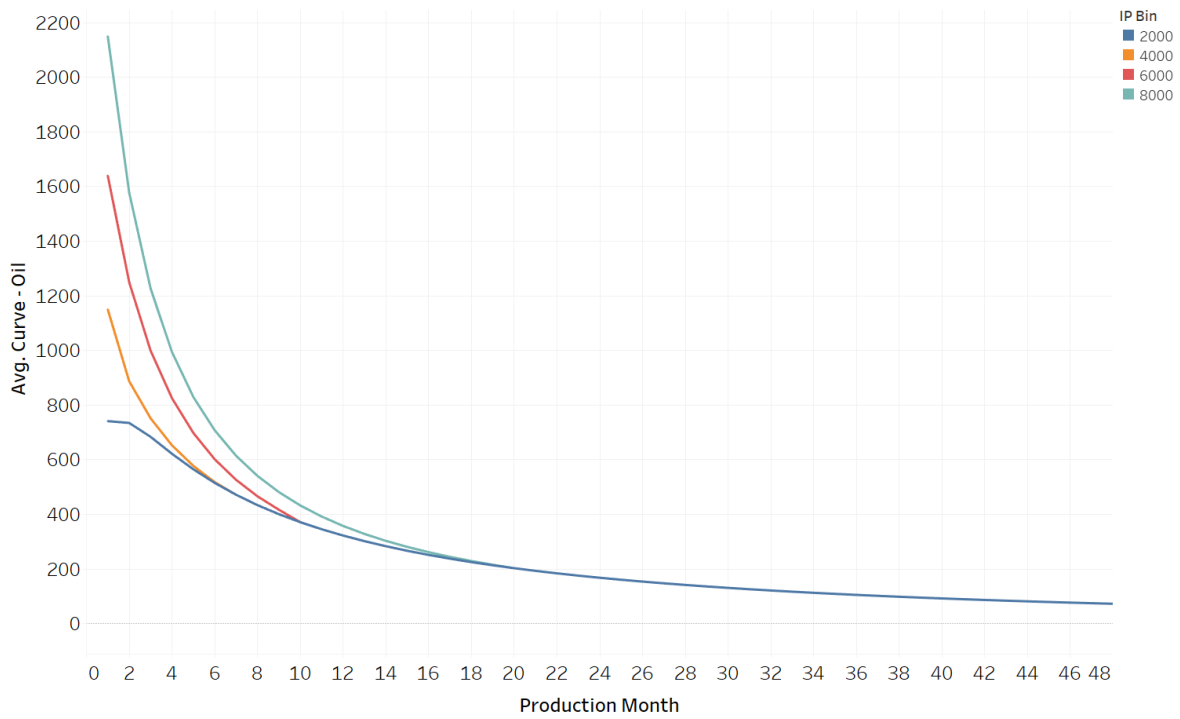
*Month "0" is a partial month with daily production calculated using "Days on production". Months 1+ use calendar days to calculate daily rate.



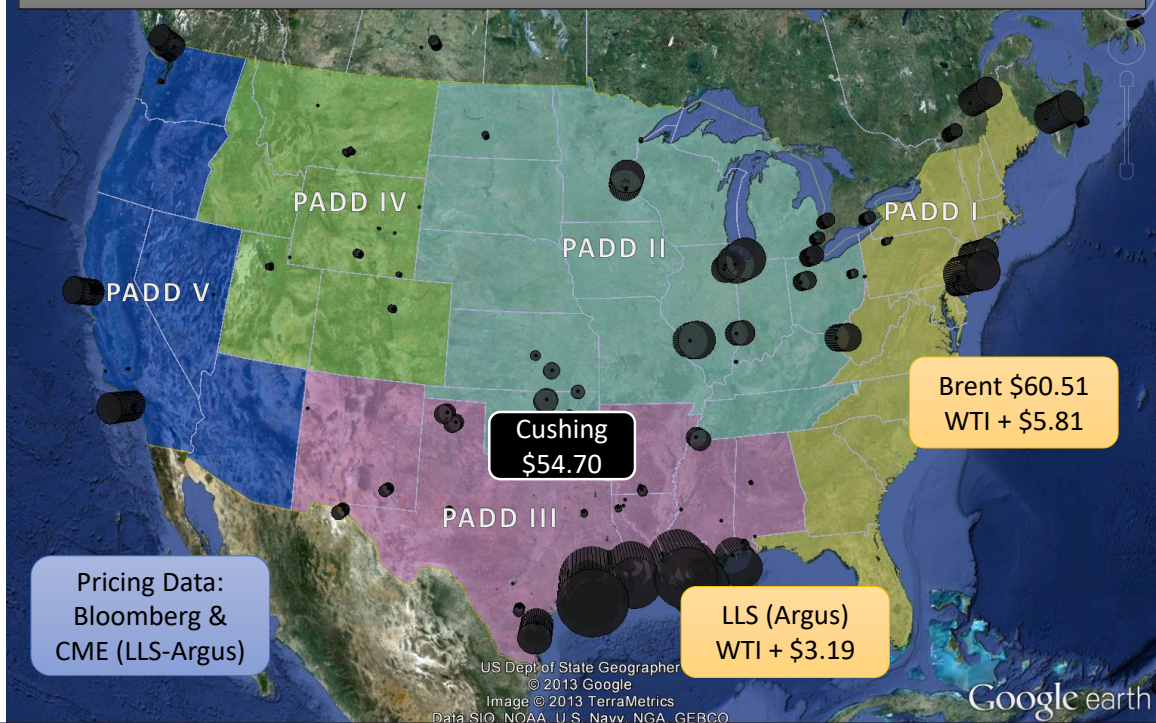
Oil IP Bin Comparison



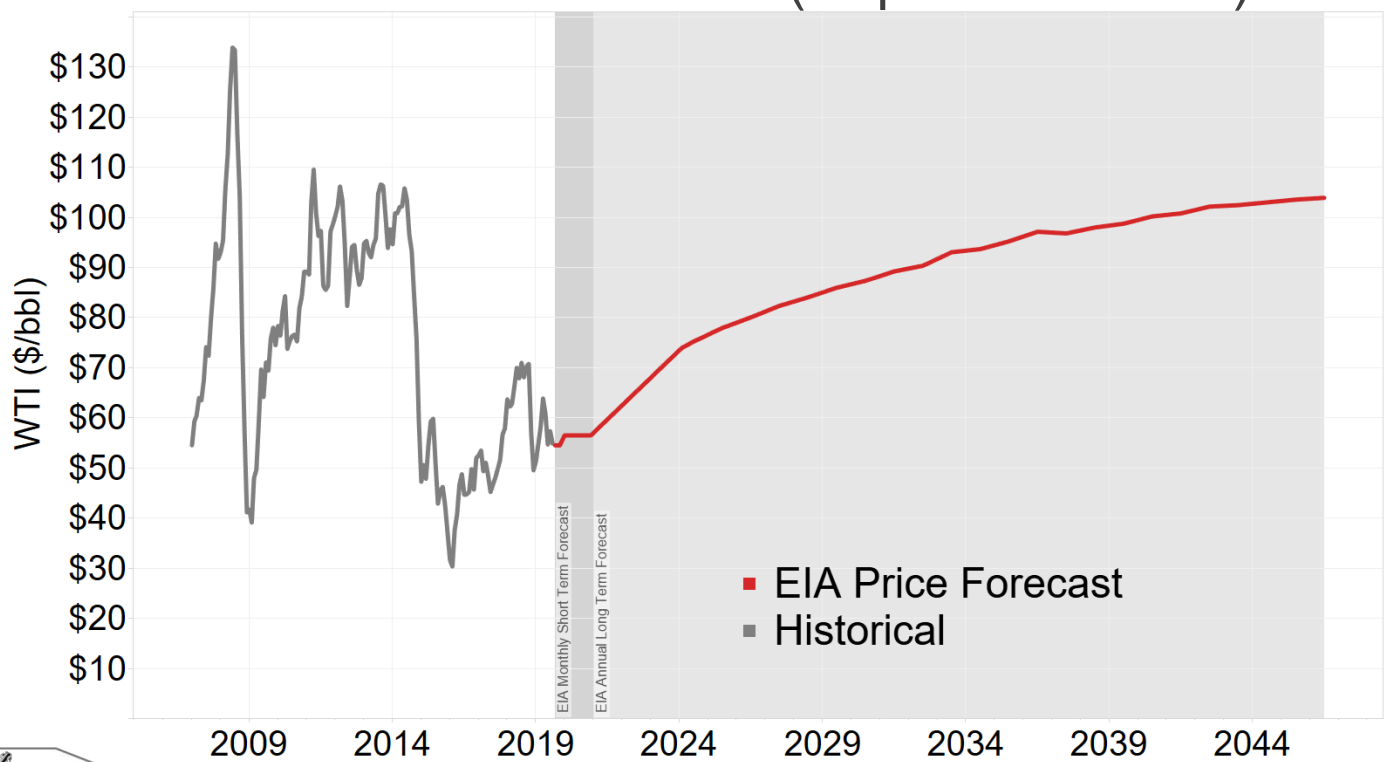
Oil IP Bin Comparison – “Clean”



Crude Oil Prices – Oct. 11, 2019

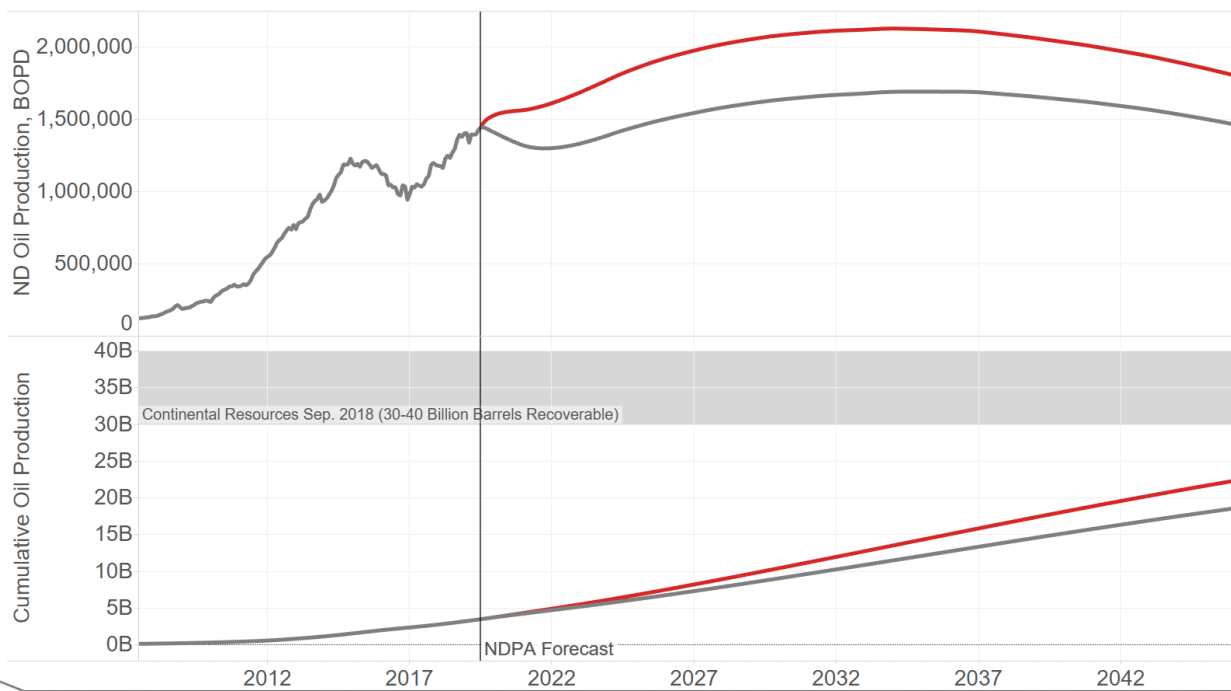


EIA Forecasted Oil Price (September 2019)

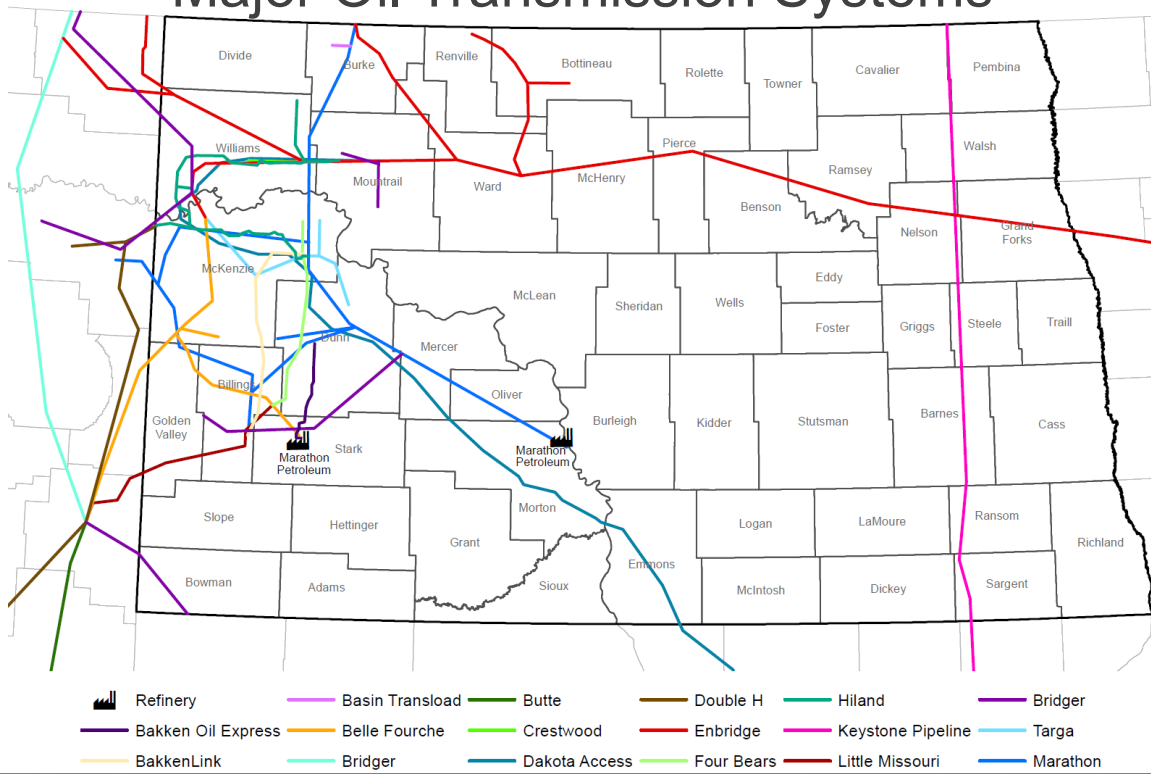


North Dakota Oil Production Forecast

Assumes Current Technology – Enhanced Oil Recovery Not Included

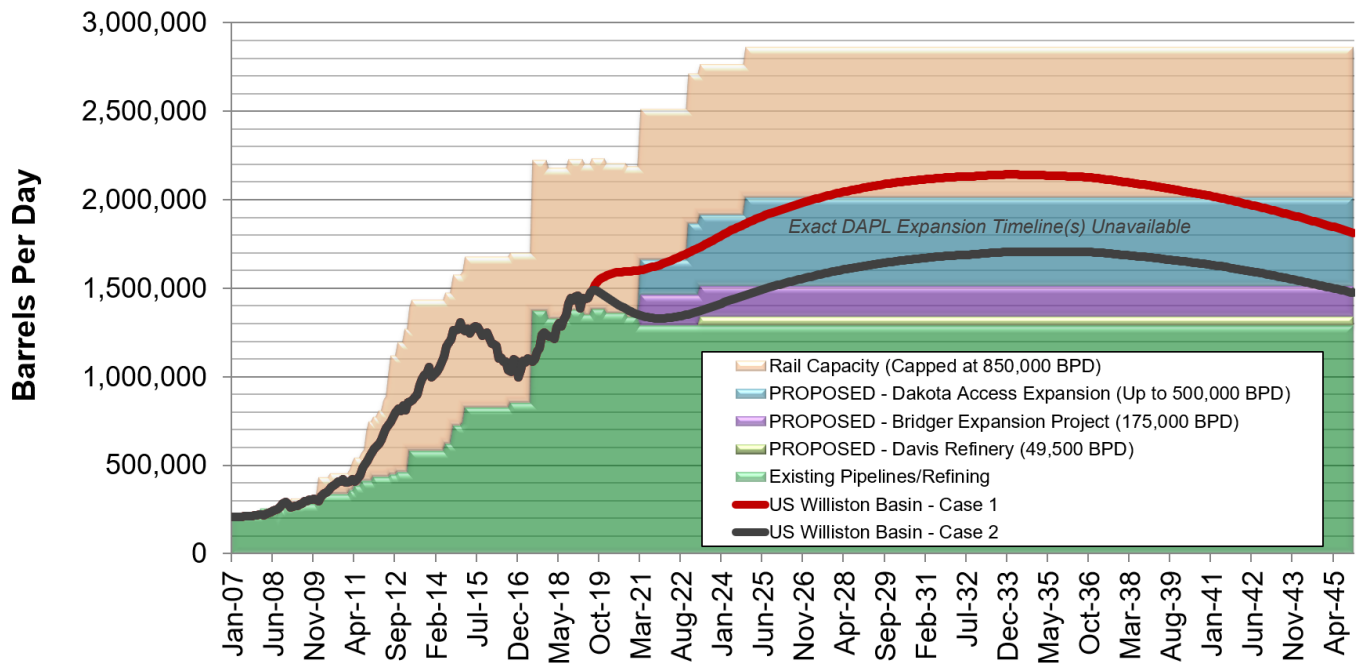


Major Oil Transmission Systems



Williston Basin Oil Production & Export Capacity, BOPD

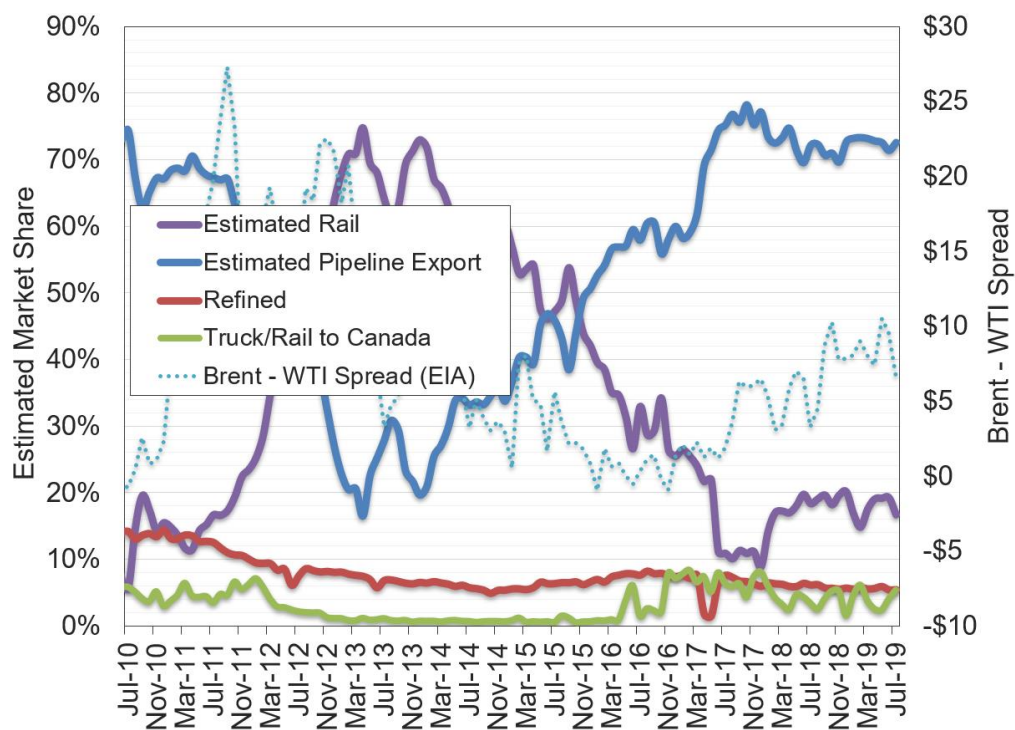
Assumes Current Technology – Enhanced Oil Recovery Not Included



Production forecast is for visual demonstration purposes only and should not be considered accurate for any near or long term planning.



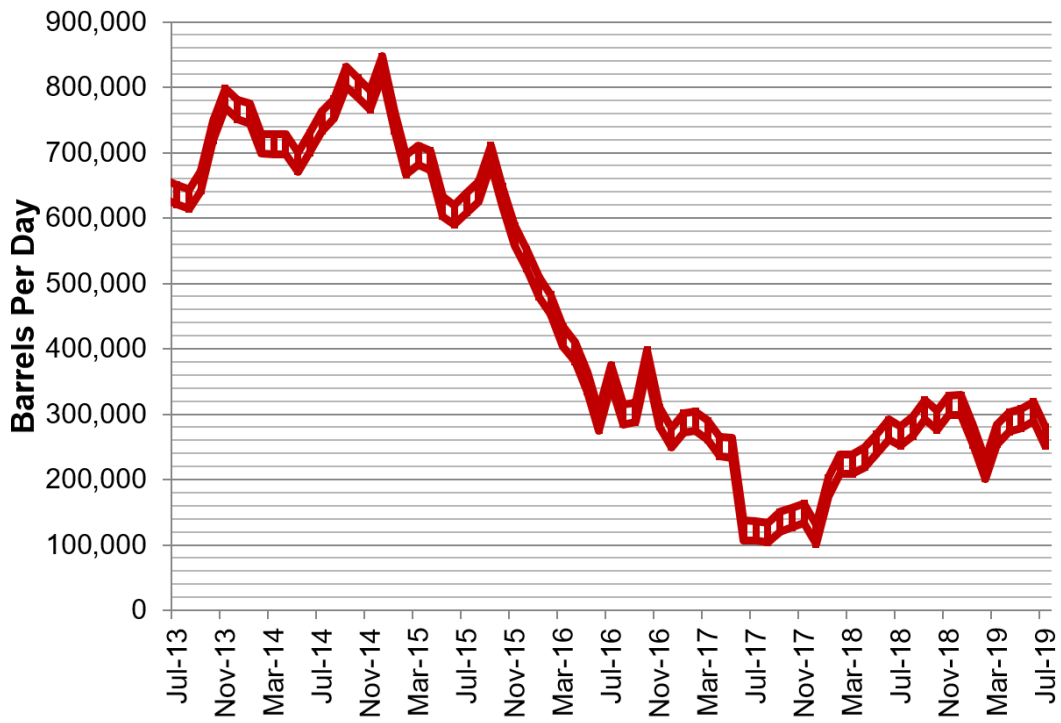
Estimated Williston Basin Oil Transportation



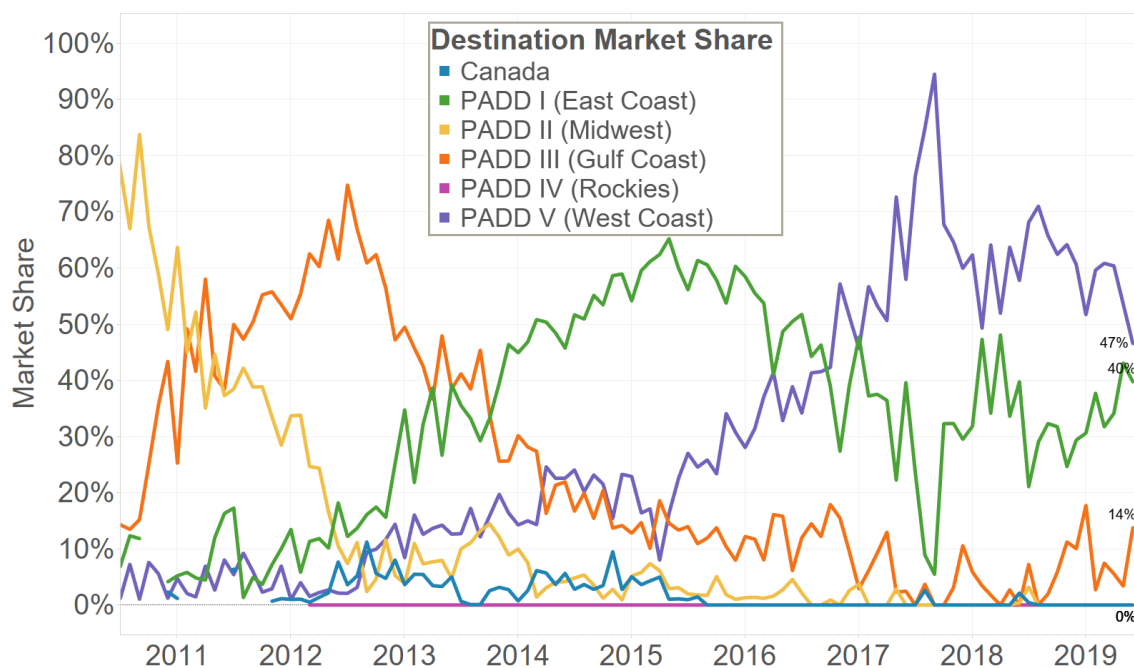
16



Estimated ND Rail Export Volumes



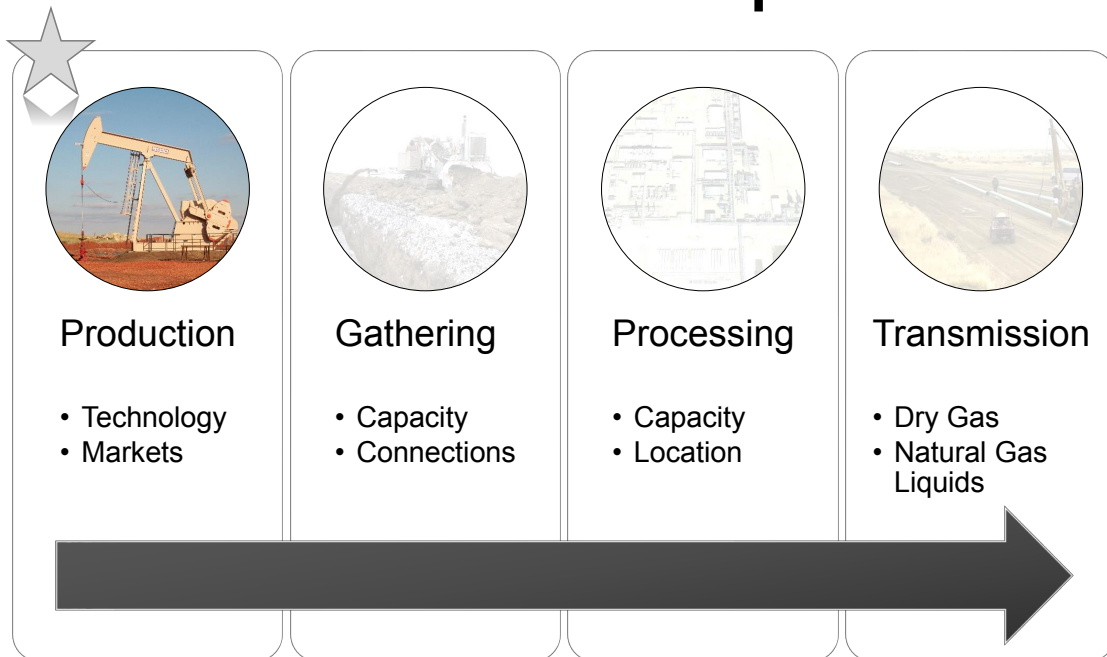
Rail Destinations Market Share (June 2019)



Data for Rail Destination Market Share Provided by the US Energy Information Administration

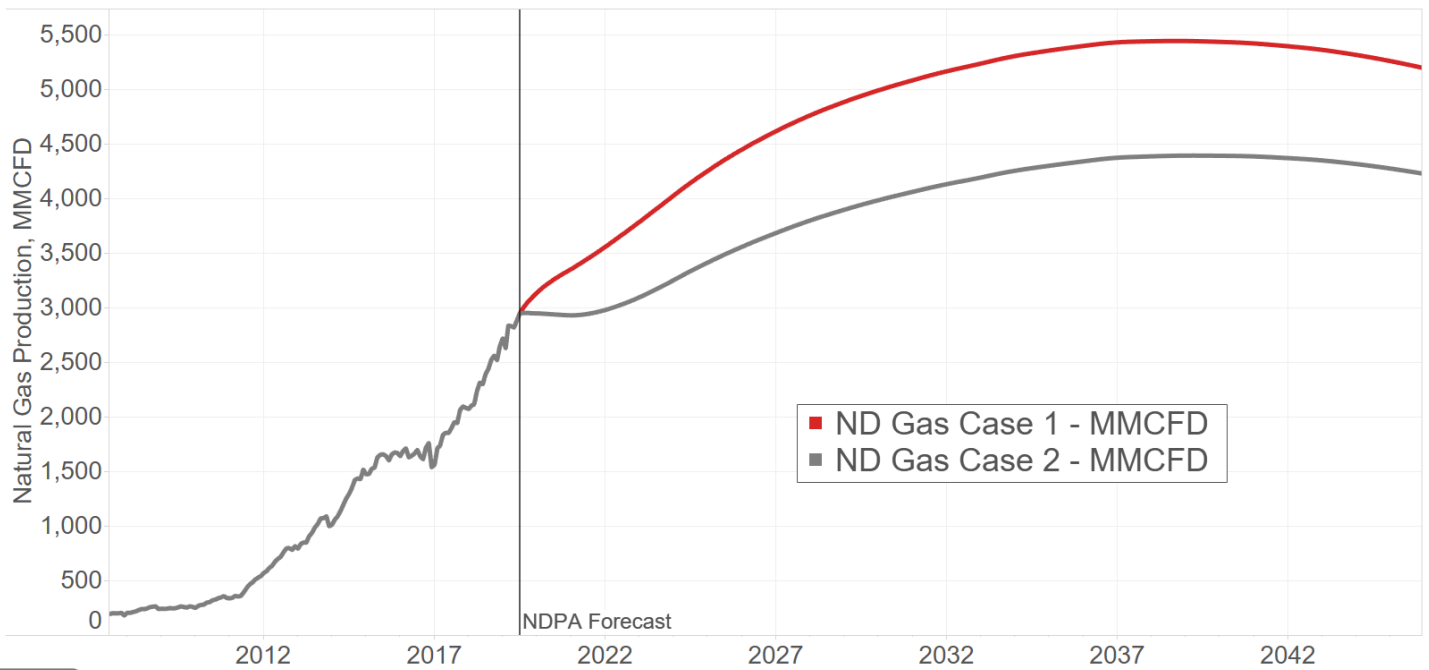


Natural Gas Update

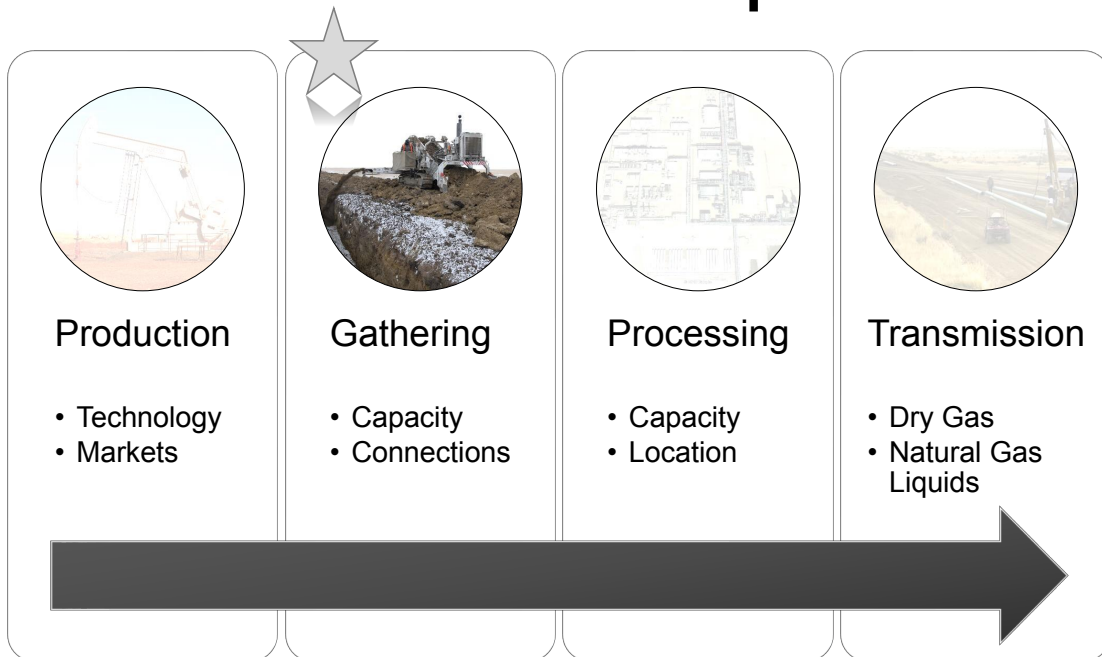


North Dakota Gas Production Forecast

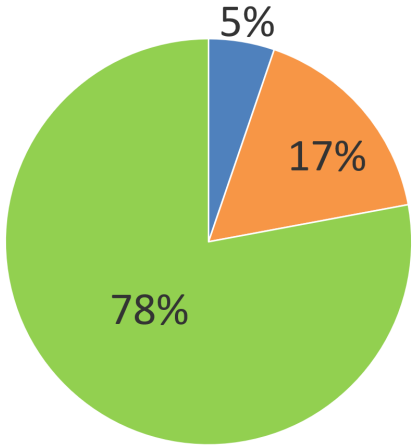
Assumes Current Technology – Enhanced Oil Recovery Not Included



Natural Gas Update



Solving the Flaring Challenge



GREEN – % of gas captured and sold
Blue – % flared from zero sales wells
Orange – % flared from wells with at least one mcf sold.

Simple Terms

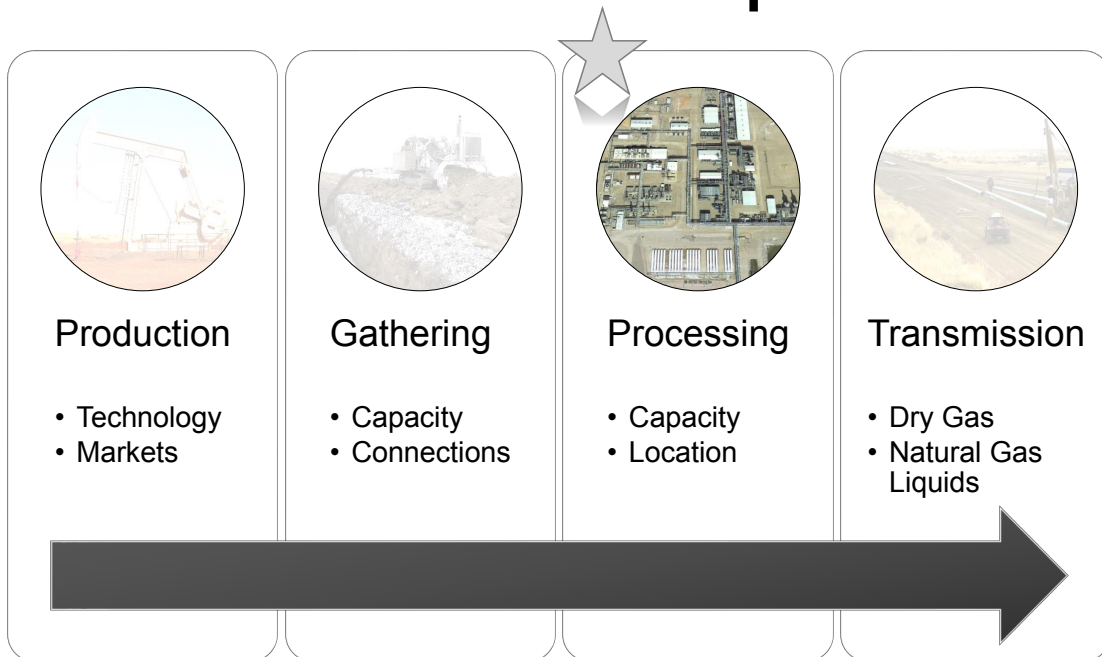
Blue – Lack of pipelines
Orange – Challenges on existing infrastructure

Statewide

July 2019 Data – Non-Confidential Wells



Natural Gas Update



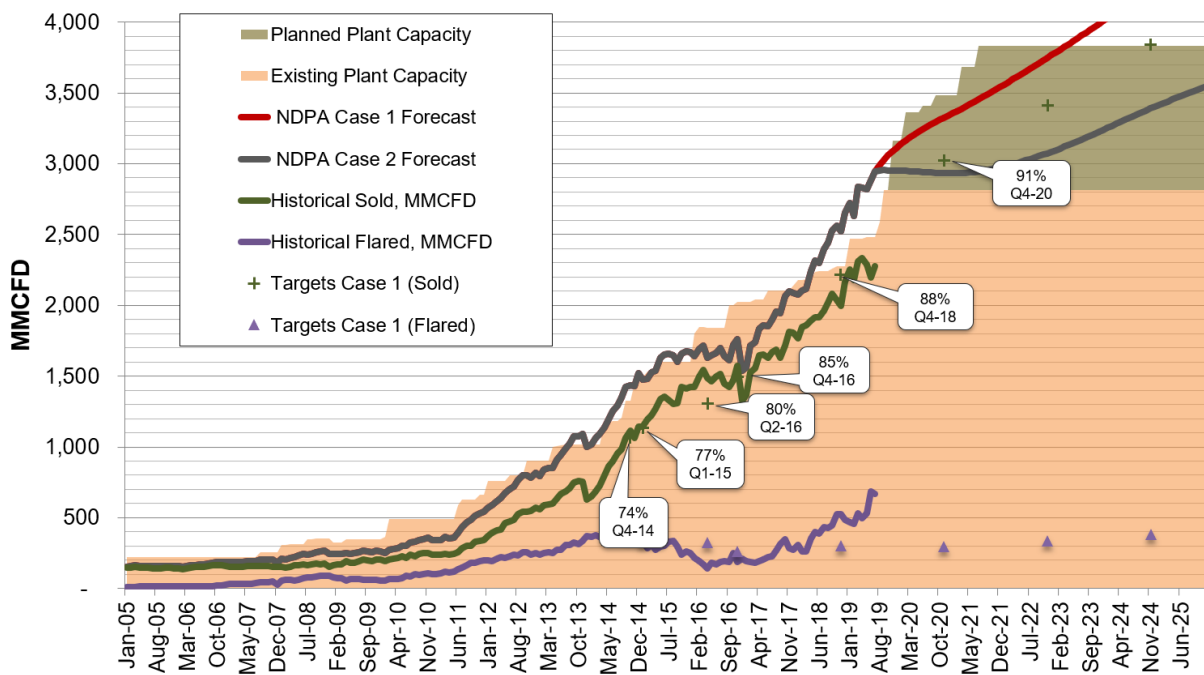
Upcoming Gas Plant Expansions, MMCFD (Dates Estimated)

| Plant Operator | Facility | County | Expansion Date | Expansion Volume |
|-----------------------|-----------------|---------------|-----------------------|-------------------------|
| ONEOK | Demicks Lake | McKenzie | Nov-19 | 200 |
| Kinder Morgan | Roosevelt | McKenzie | Nov-19 | 150 |
| ONEOK | Demicks Lake II | McKenzie | Feb-20 | 200 |
| ONEOK | Bear Creek | Dunn | Jun-20 | 45 |
| XTO - Nesson | Ray | Williams | Sep-20 | 75 |
| ONEOK | Bear Creek II | Dunn | Mar-21 | 200 |
| Hess | Tioga | Williams | Jul-21 | 150 |



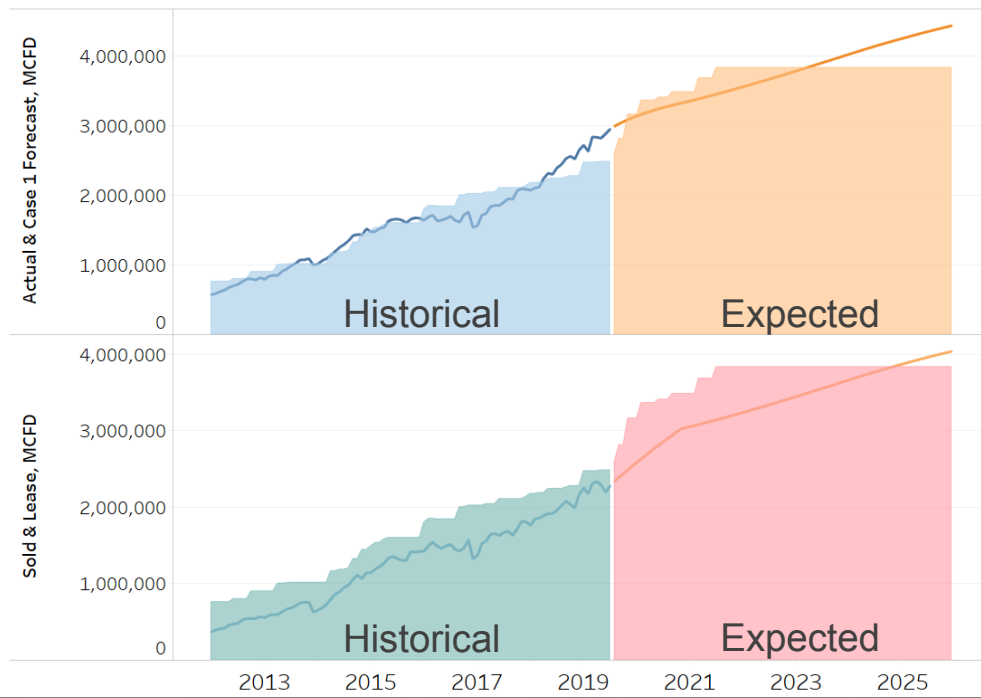
Solving the Flaring Challenge

Assumes Current Technology – Enhanced Oil Recovery Not Included

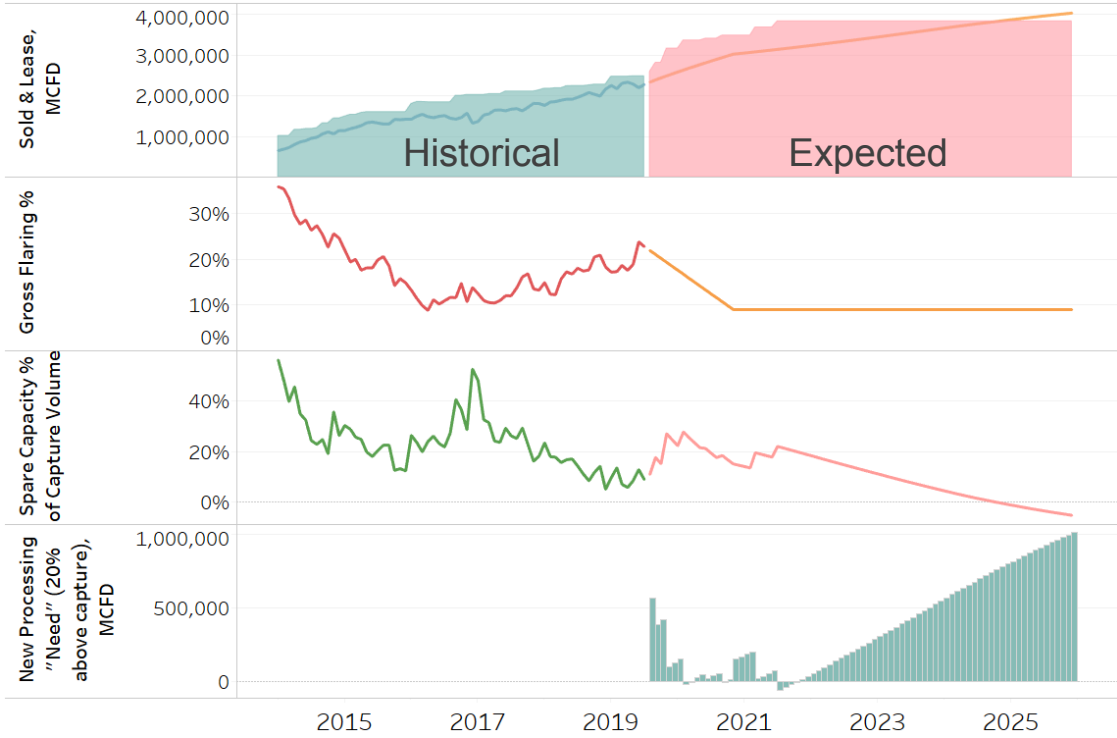


Gas Processing Capacity & Future Outlook

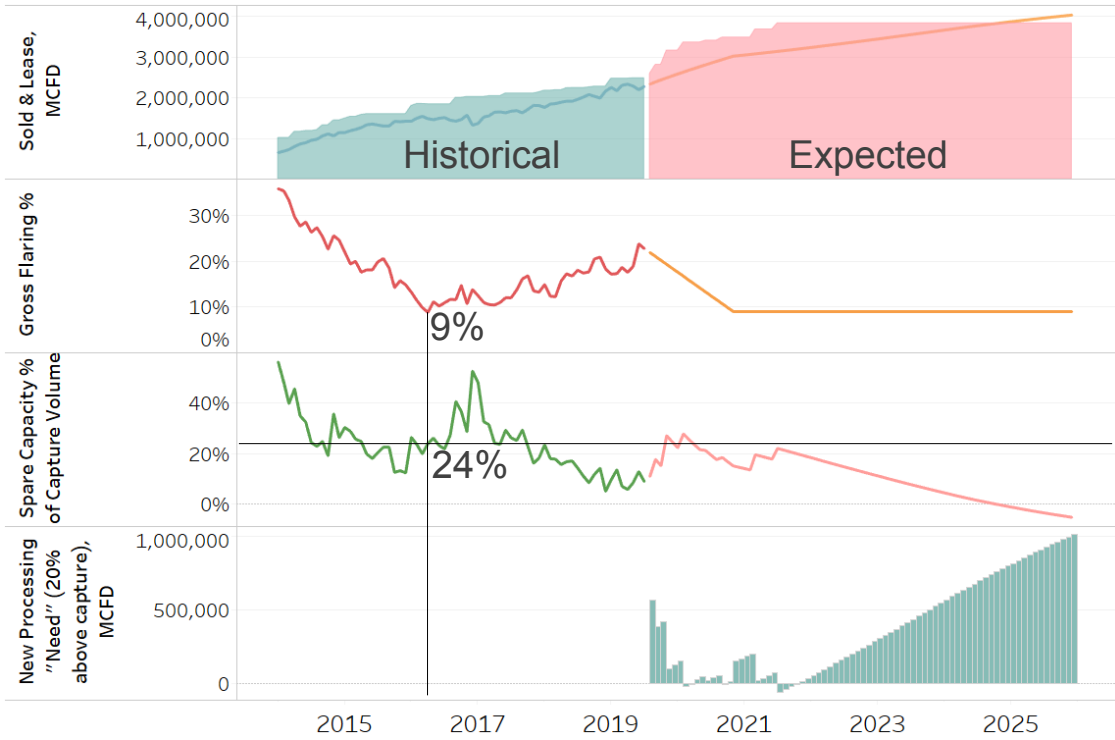
Assumes Current Technology – Enhanced Oil Recovery Not Included



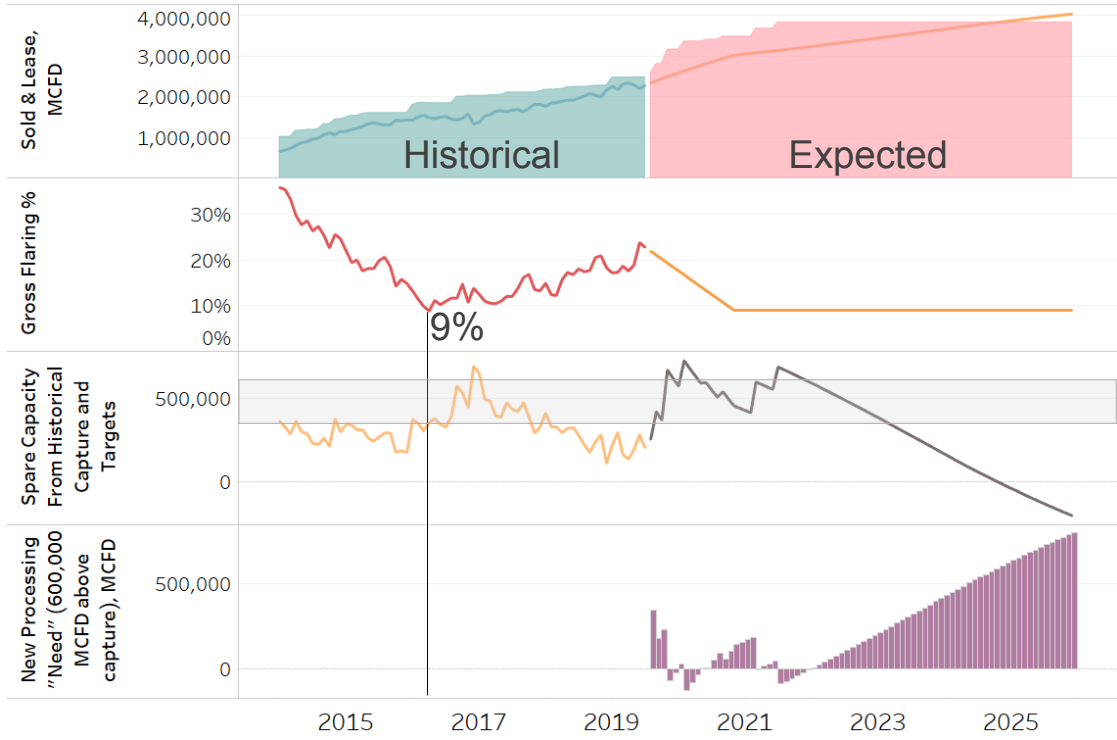
Gas Processing Capacity & Spare Capacity



Gas Processing Capacity & Spare Capacity

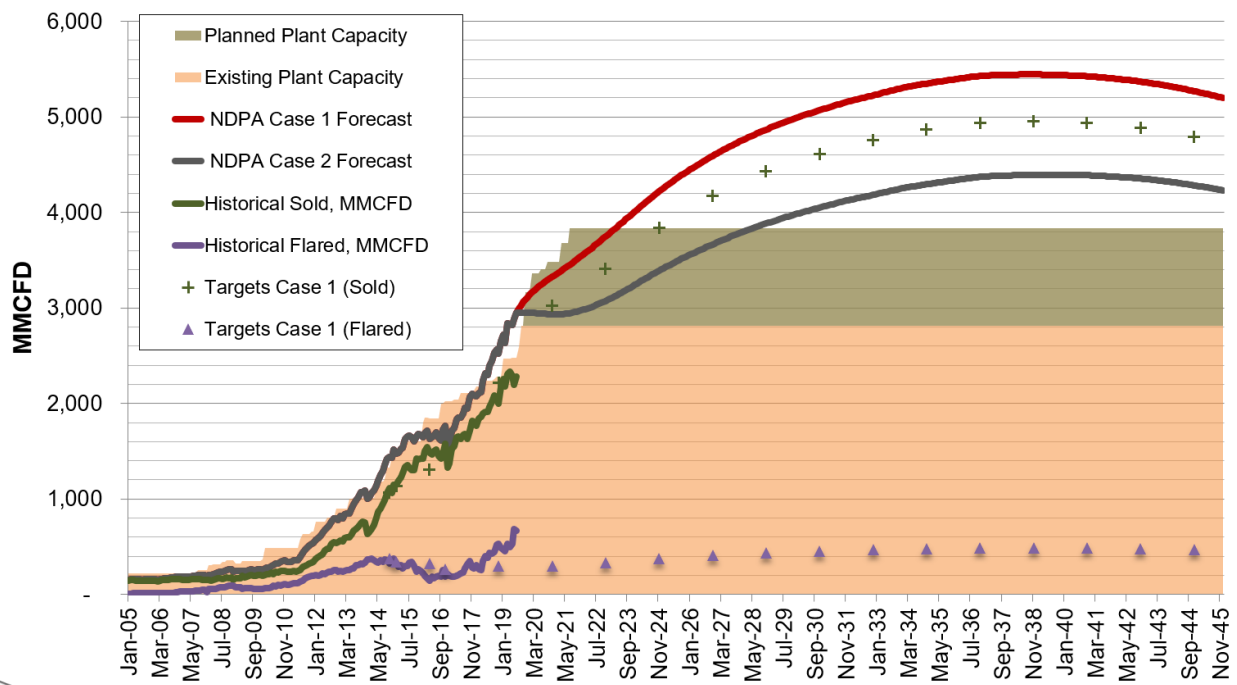


Gas Processing Capacity & Spare Capacity

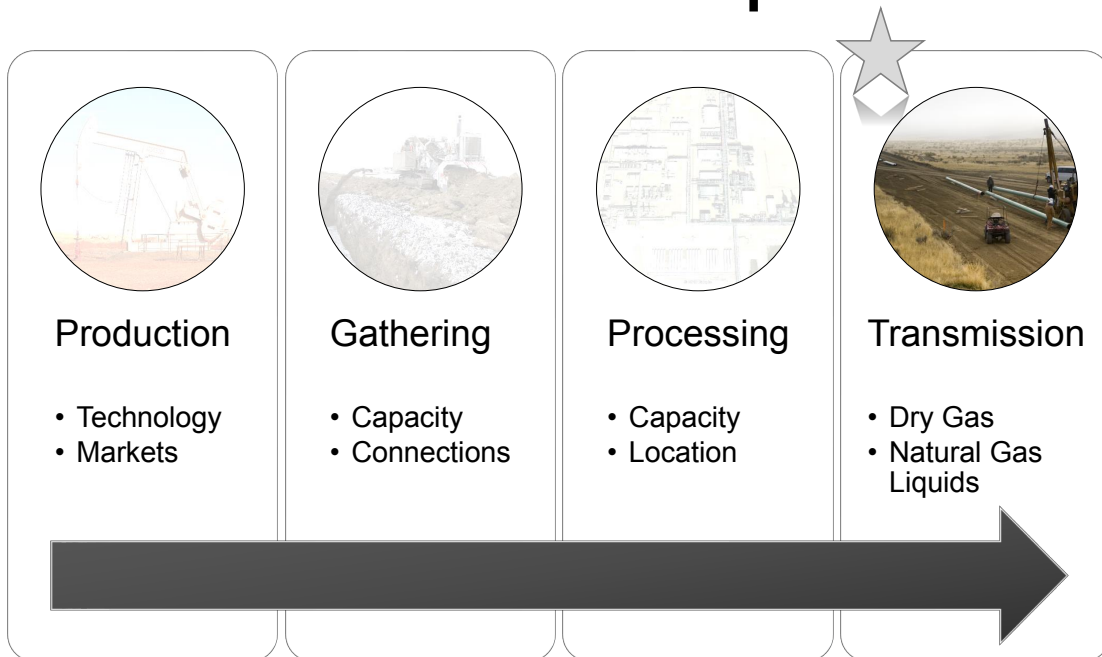


Solving the Flaring Challenge

Assumes Current Technology – Enhanced Oil Recovery Not Included

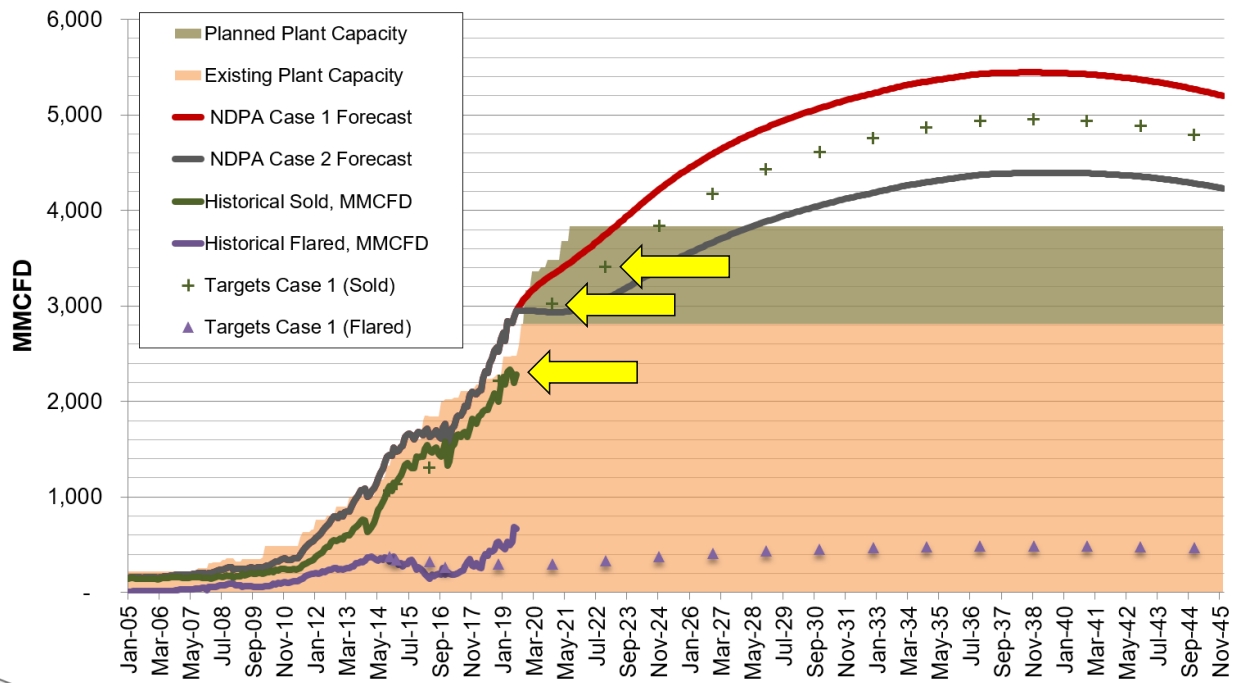


Natural Gas Update

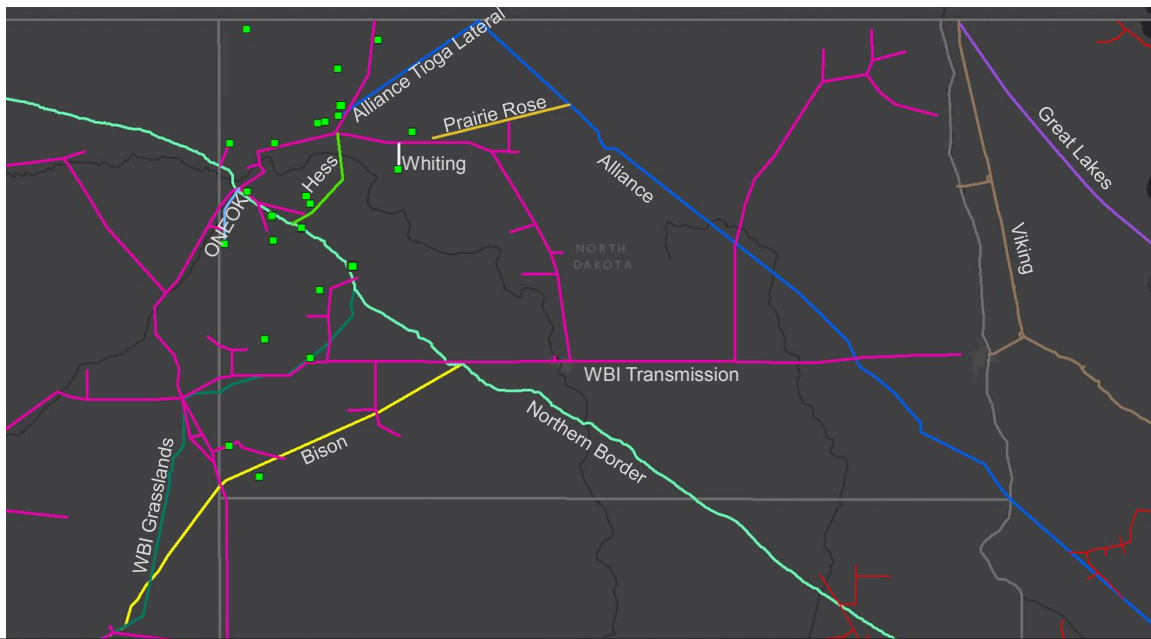


Solving the Flaring Challenge

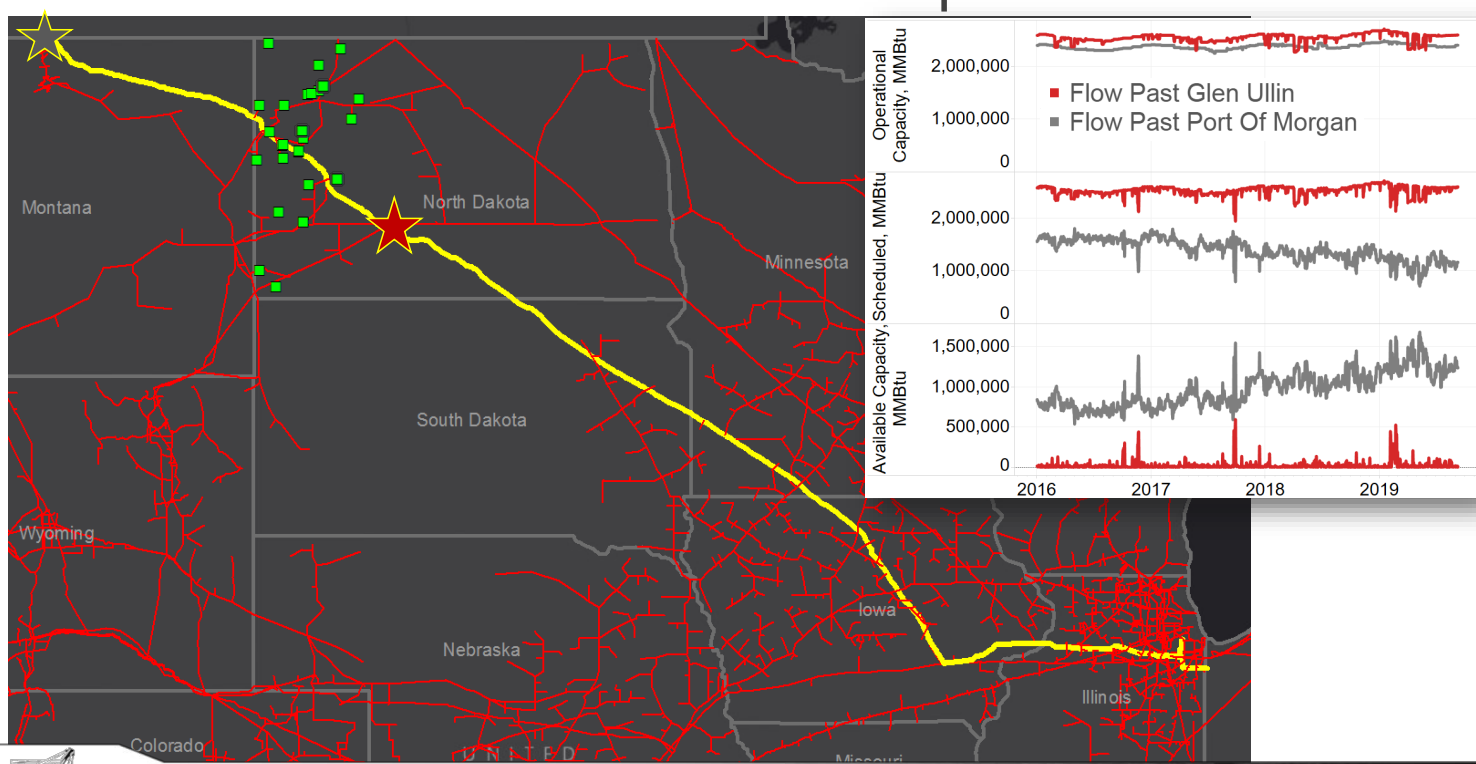
Assumes Current Technology – Enhanced Oil Recovery Not Included



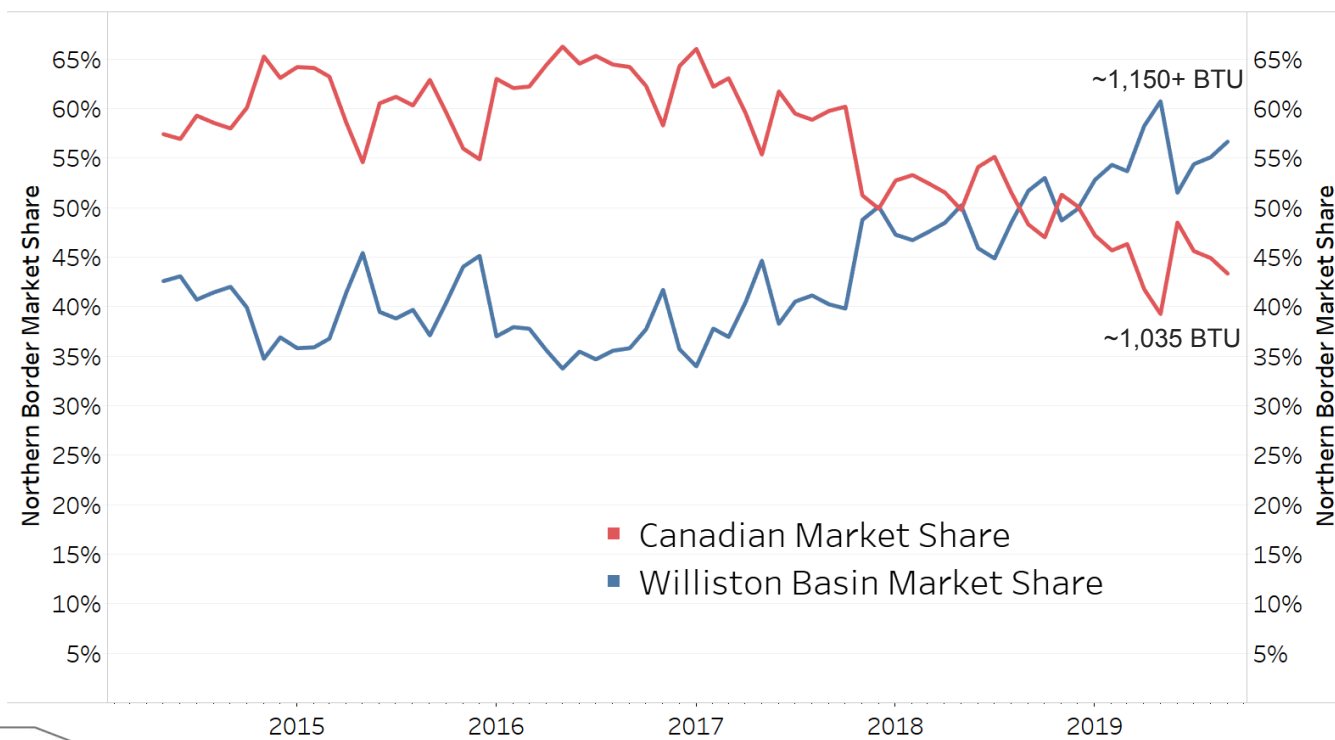
Major Gas Pipeline and Processing Infrastructure



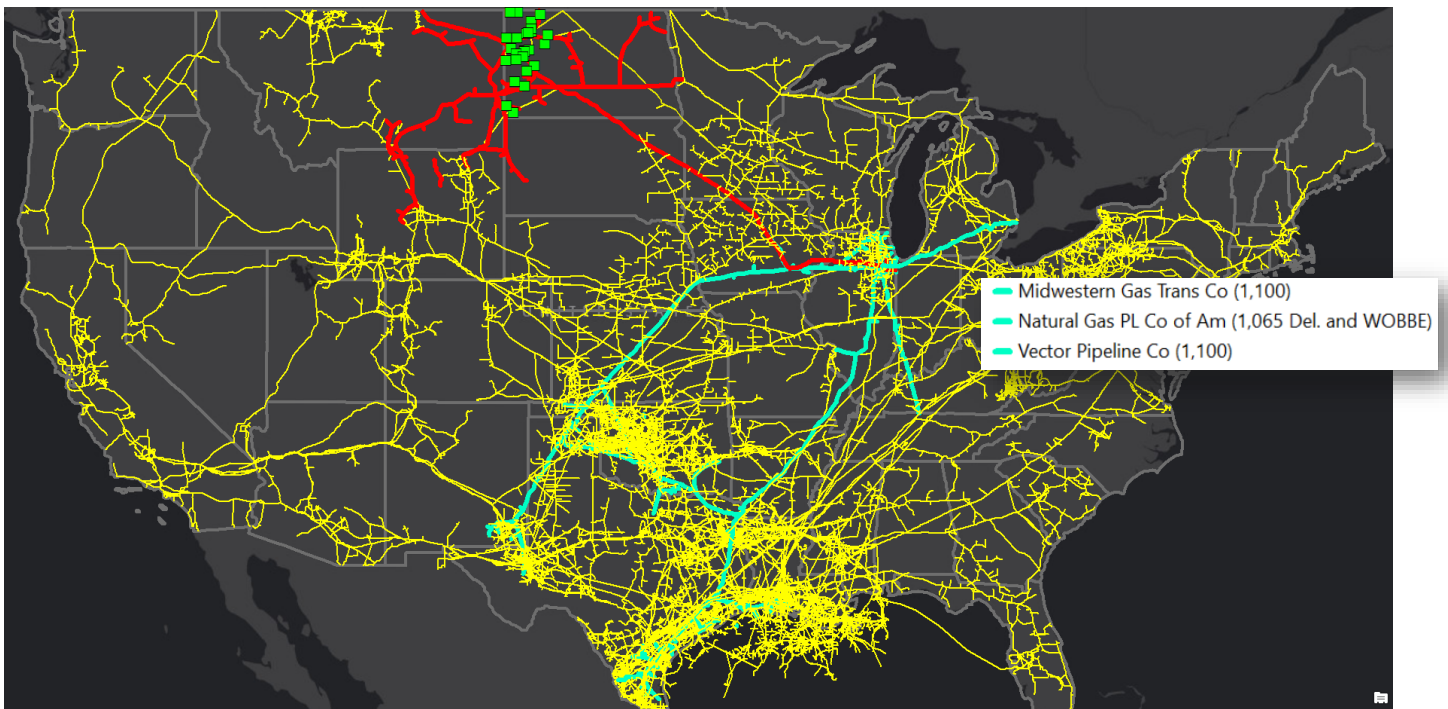
Northern Border Pipeline



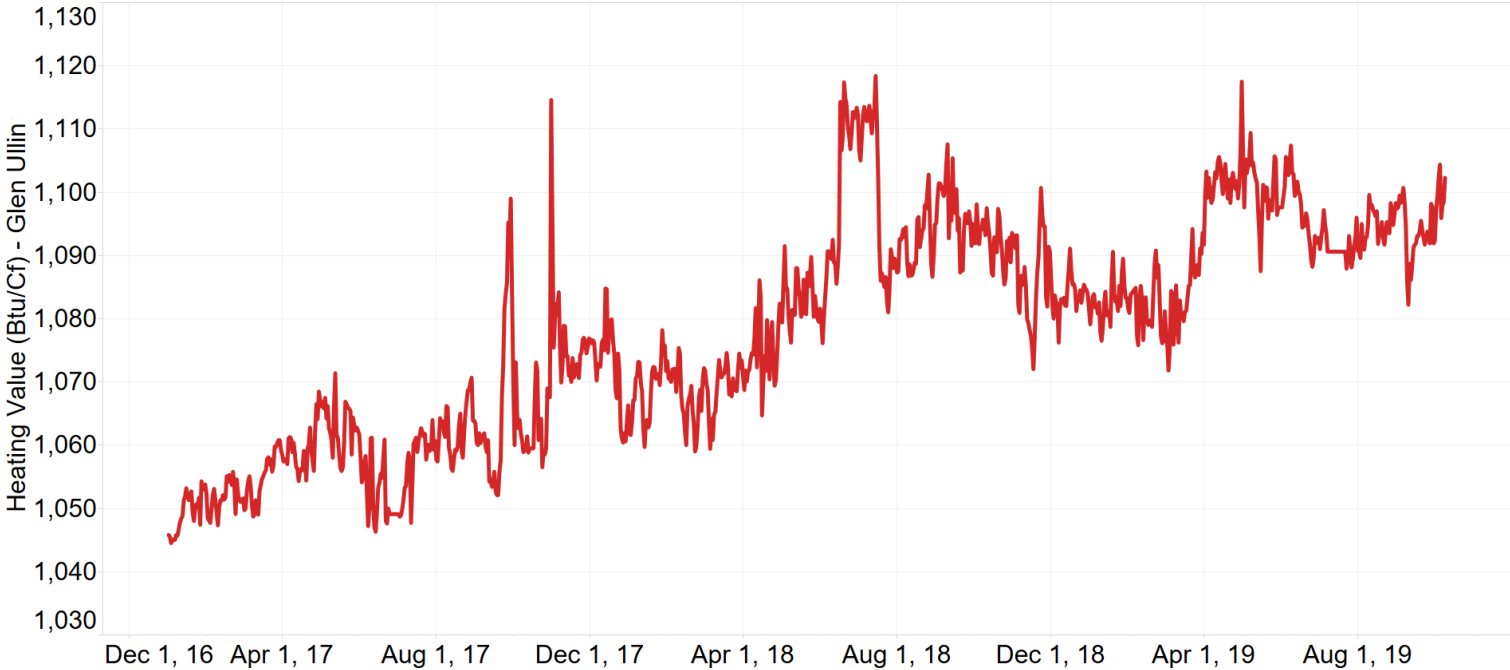
Northern Border Pipeline Market Share

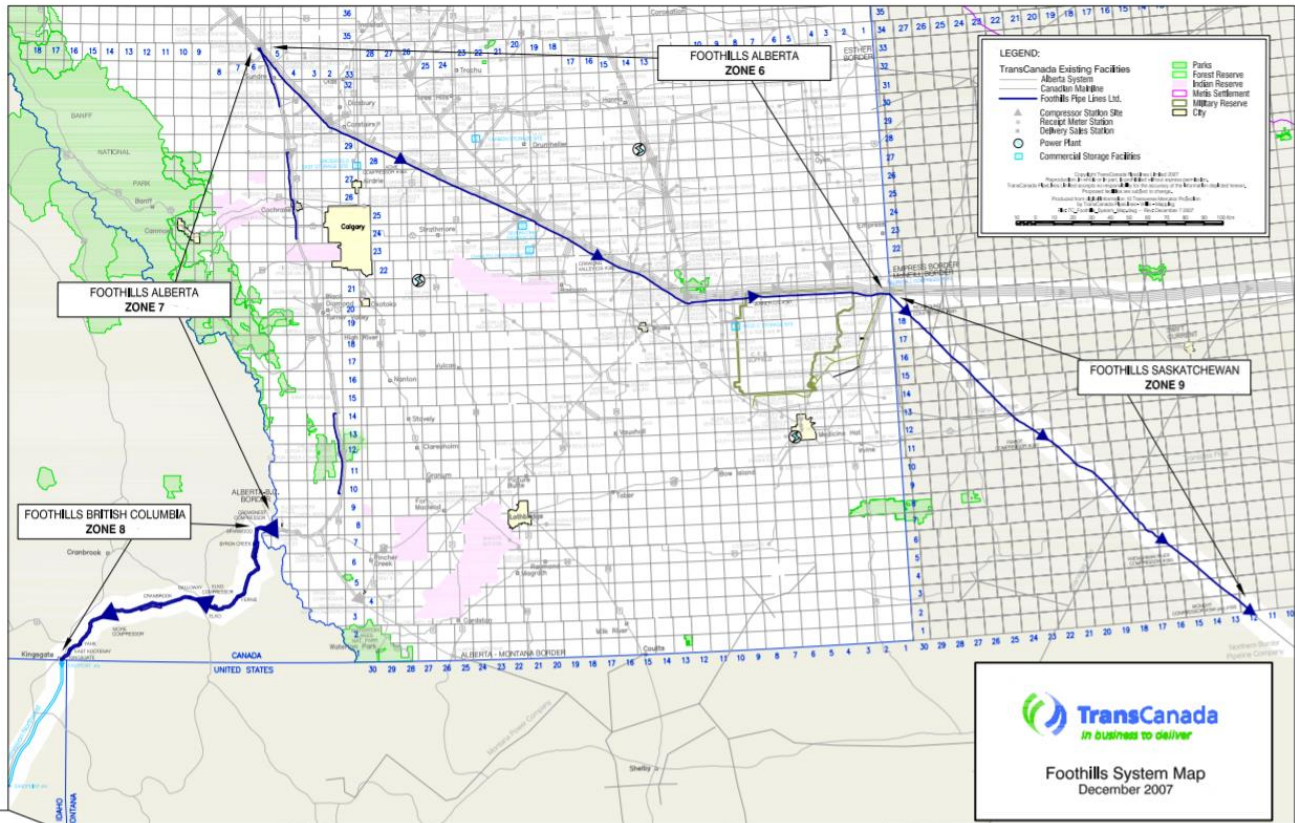


NB Pipeline Interconnects With Known BTU Limits

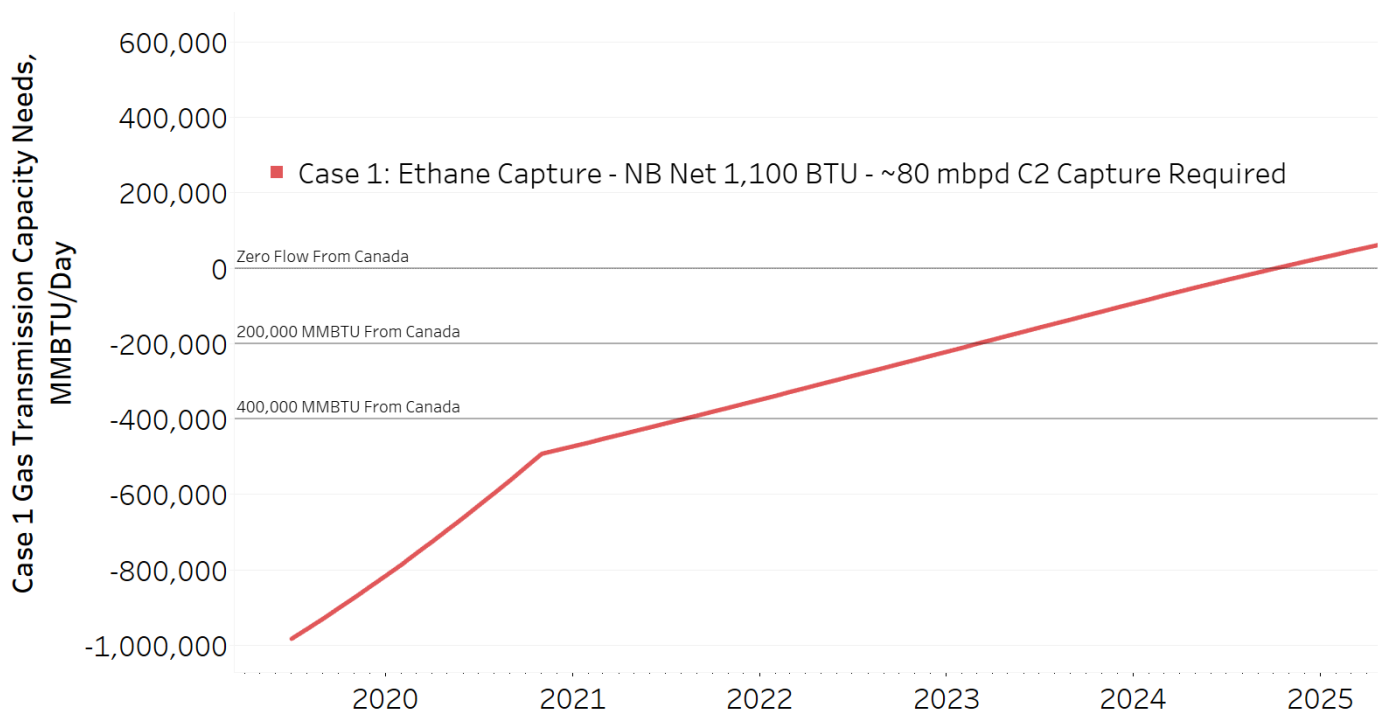


Northern Border BTU at Glen Ullin, ND



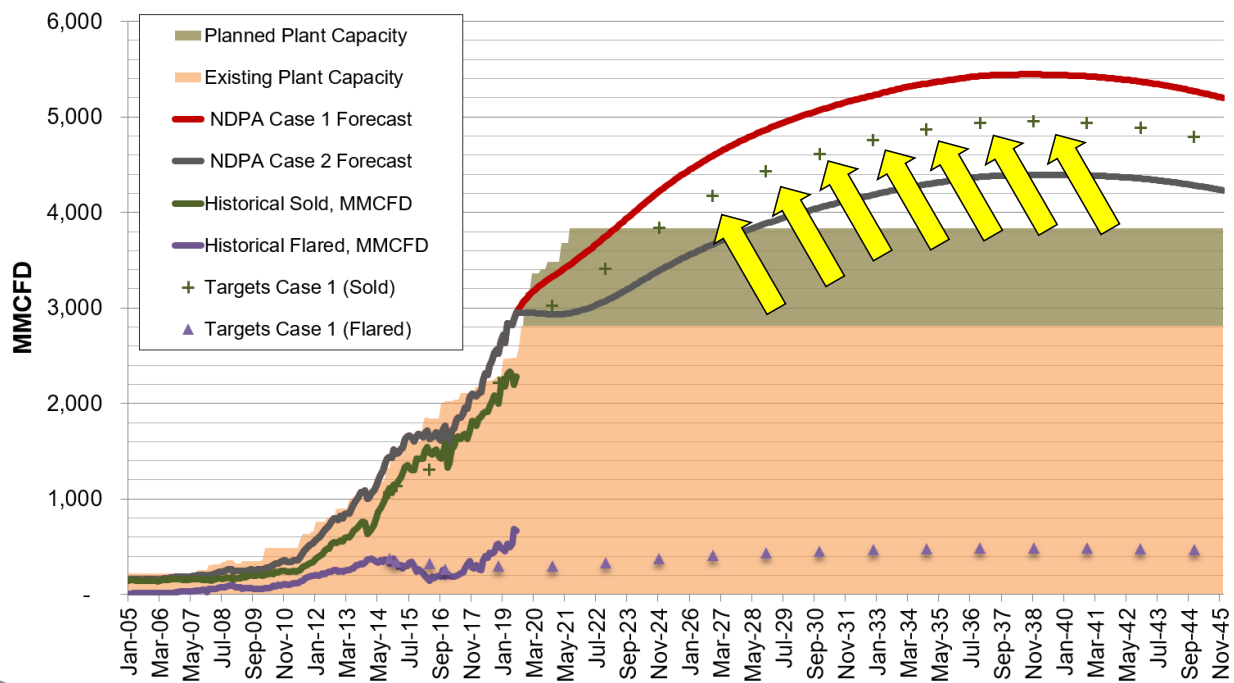


Northern Border – BTU Calculations*

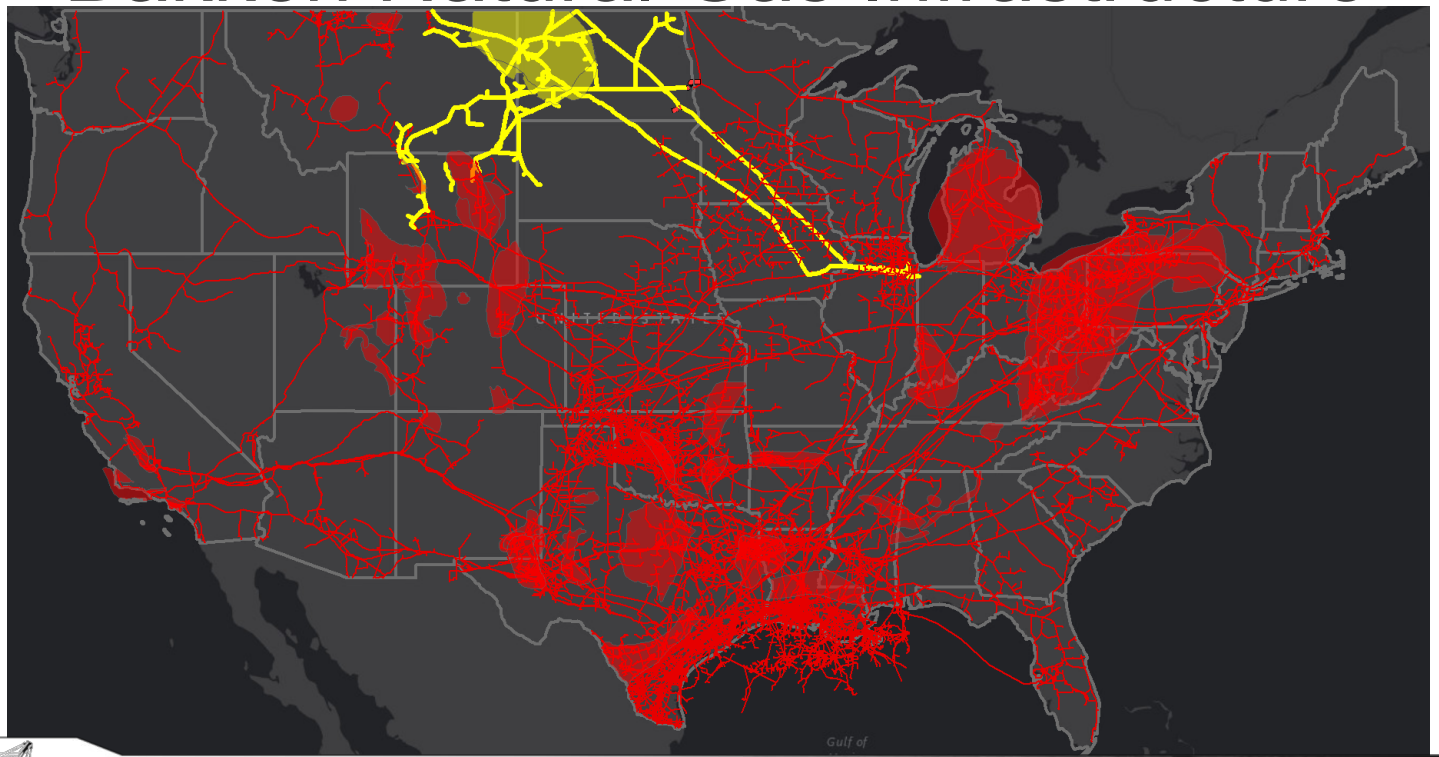


Solving the Flaring Challenge

Assumes Current Technology – Enhanced Oil Recovery Not Included

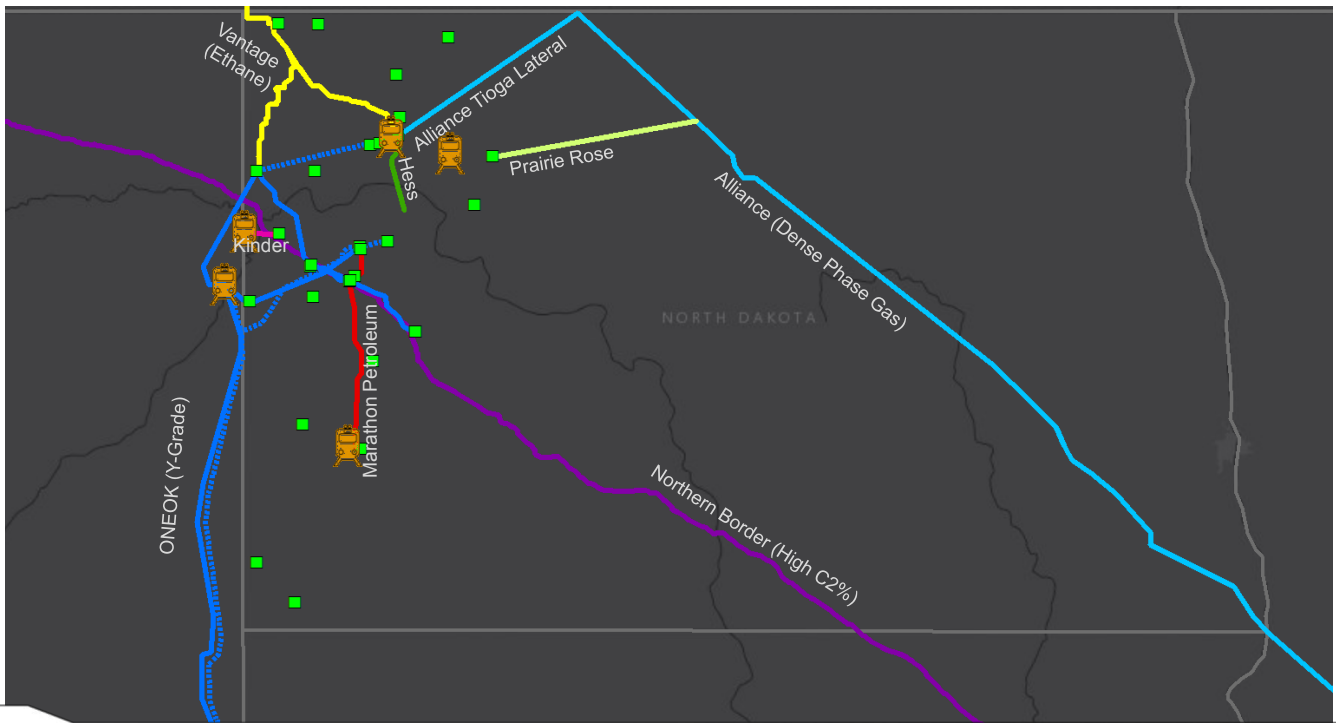


Bakken Natural Gas Infrastructure



Bakken & Three Forks Natural Gas Liquids Chemistry

Regional NGL Infrastructure



Bakken – Three Forks NGL Content

EPRINC

the richer gas plays in the country.⁶ Because of this, the cost of flaring is actually greater in North Dakota's Bakken than in other plays (see figure 11 below).

Figure 11. Gallons of Natural Gas Liquids per Mcf by Shale Play

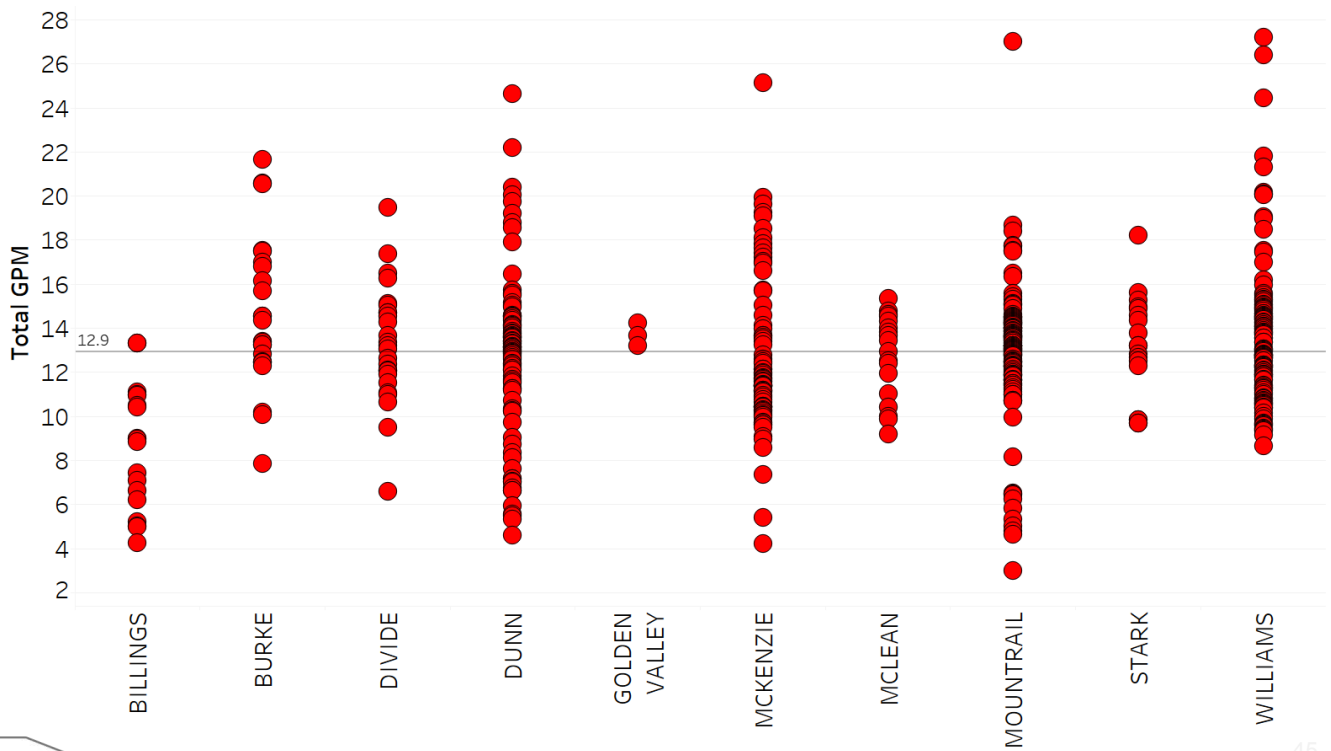
| Rich Gas Shales | NGL GPM ¹ |
|-----------------------------------|----------------------|
| Avalon/ Bone Springs ² | 4.0 to 5.0 |
| Bakken ² | 6.0 to 12.0 |
| Barnett | 2.5 to 3.5 |
| Cana-Woodford | 4.0 to 6.0 |
| Eagle Ford ³ | 4.0 to 9.0 |
| Granite Wash | 4.0 to 6.0 |
| Green River ² | 3.0 to 5.0 |
| Niobrara ² | 4.0 to 9.0 |
| Piceance-Uinta | 2.5 to 3.5 |
| Montney | 3.0 to 4.5 |
| Marcellus-Utica ³ | 4.0 to 9.0 |
| 1. GPM = gallons NGLs per mcf | |
| 2. Oil Shale Plays | |
| 3. Oil and Gas Shale Play | |

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

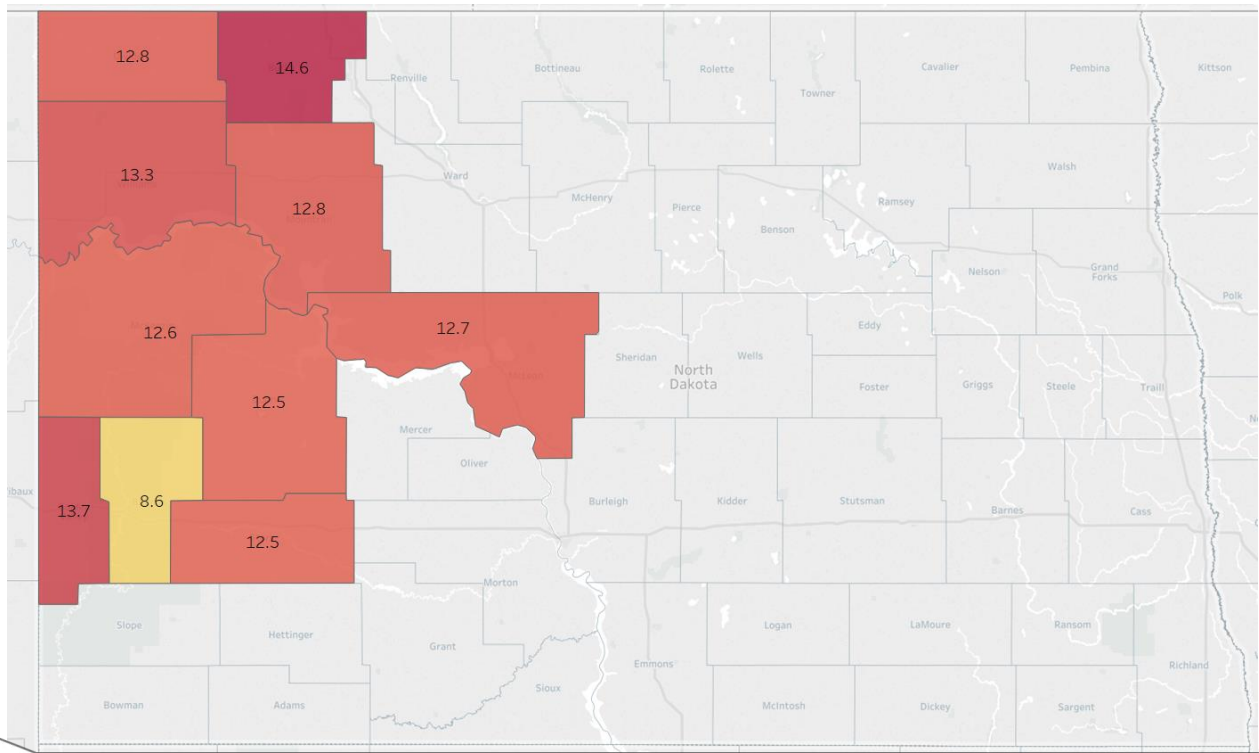
• Actual Bakken/Three Forks NGL GPM 10 to 12+
(See Supporting Slides)



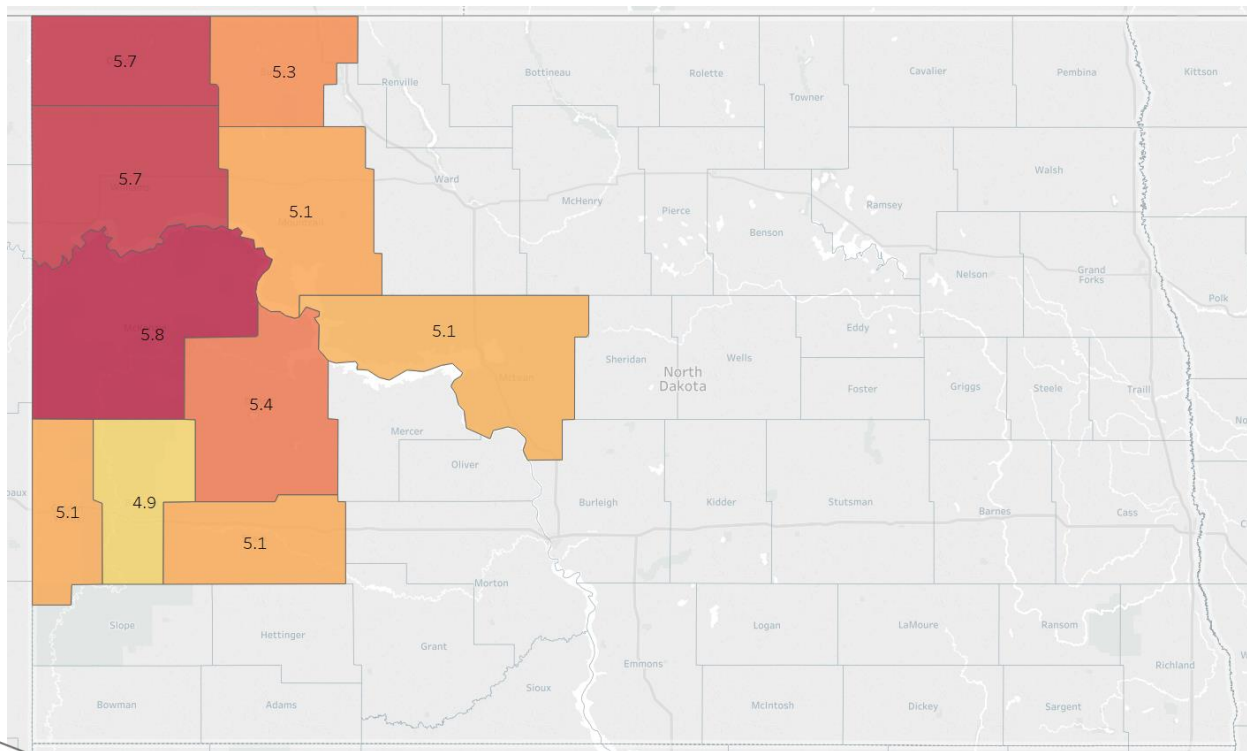
Bakken – Three Forks Average NGL Content (GPM)



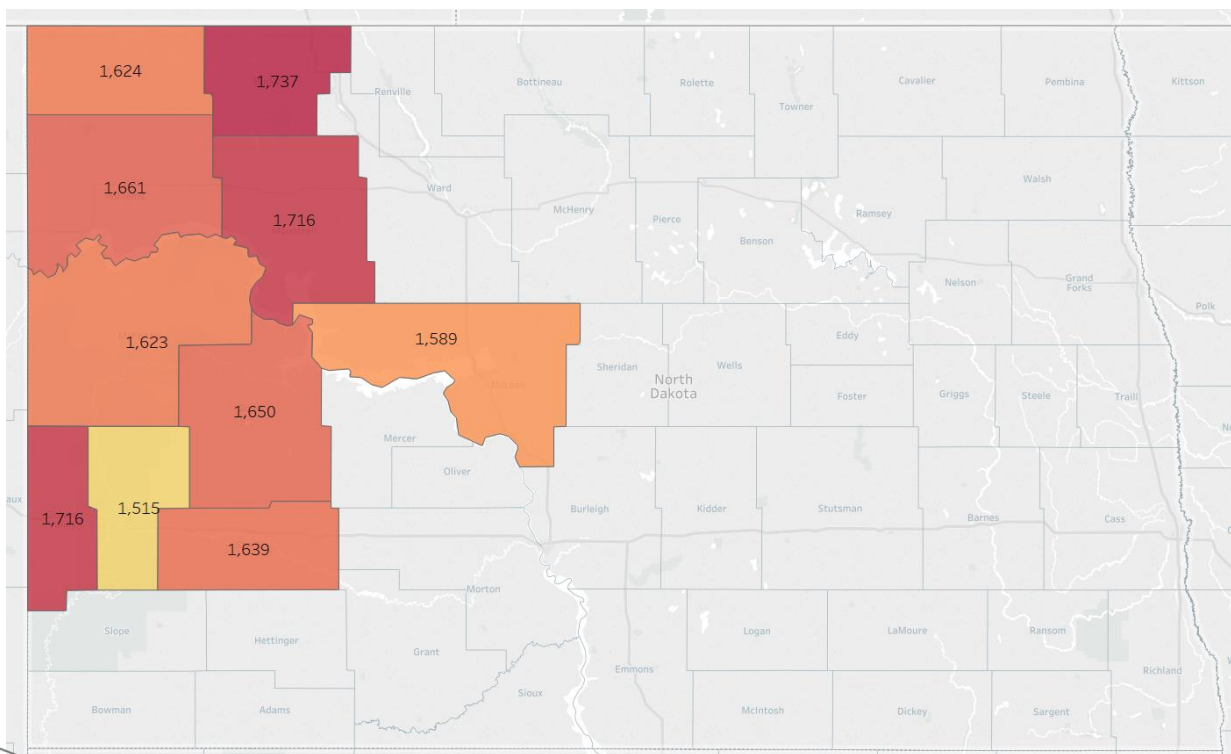
Bakken – Three Forks Average NGL Content (GPM)



Bakken – Three Forks Average Ethane Content (GPM)



Bakken – Three Forks Average Gas BTU



Assumed NGL Content for NDPA NGL Forecasts

| Component | Mole % | GPM | % of Liquids |
|------------------|---------------|--------------|---------------|
| Nitrogen | 5.21% | NA | NA |
| Carbon Dioxide | 0.57% | NA | NA |
| Hydrogen Sulfide | 0.01% | NA | NA |
| Methane | 57.67% | NA | NA |
| Ethane | 19.94% | 5.32 | 52.5% |
| Propane | 11.33% | 3.11 | 30.7% |
| Isobutane | 0.97% | 0.32 | 3.1% |
| Normal Butane | 2.83% | 0.89 | 8.8% |
| Isopentane | 0.38% | 0.14 | 1.4% |
| Normal Pentane | 0.55% | 0.20 | 2.0% |
| Hexane+ | 0.36% | 0.16 | 1.5% |
| Totals | 99.82% | 10.14 | 100.0% |

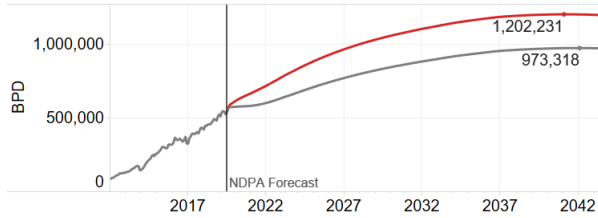
| | |
|-----------------------------|--------------|
| Gas Stream BTU Value | 1,399 |
|-----------------------------|--------------|

Mole % Source: Energy & Environmental Research Center (EERC)

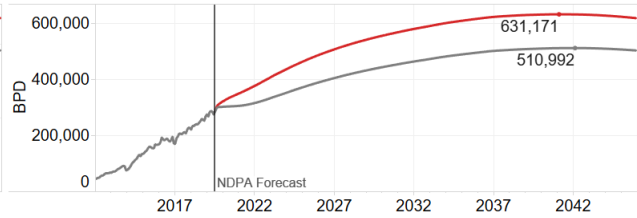


North Dakota Captured* NGL's

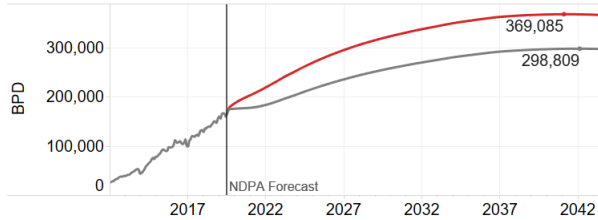
All Natural Gas Liquids



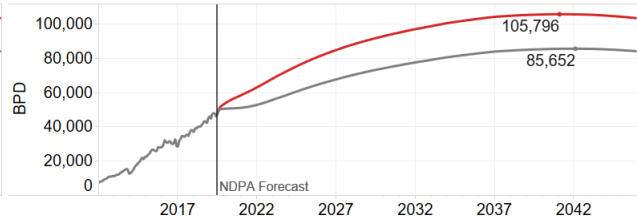
Ethane



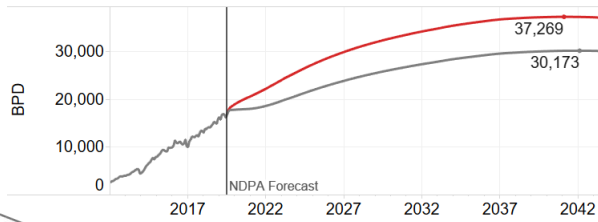
Propane



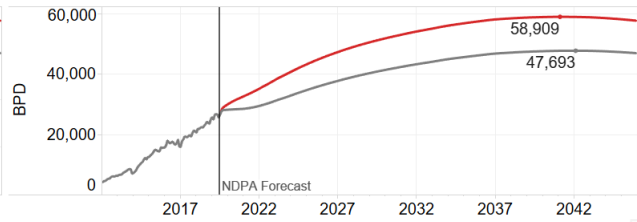
Butane



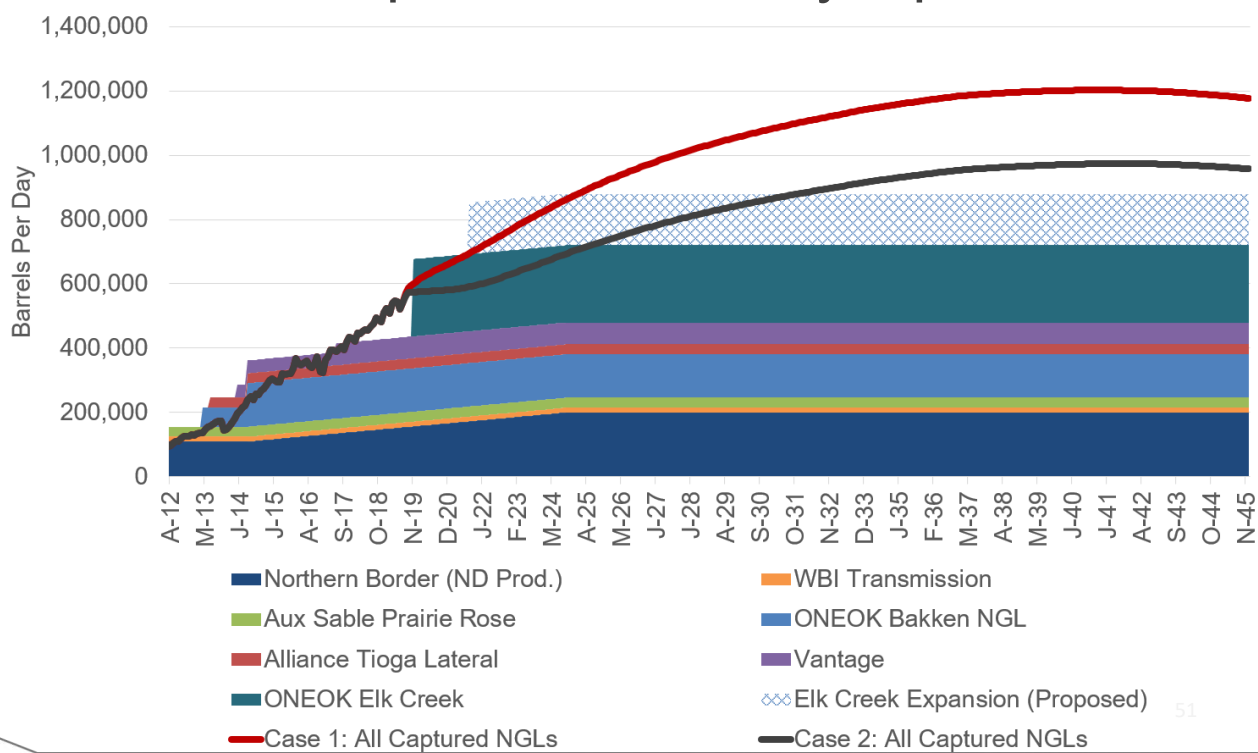
Isobutane



Natural Gasoline



NGL Pipeline Takeaway Options



Contact Information

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Fax: (701)328-2820
E-mail: jjkringstad@ndpipelines.com



Know what's below.
Call before you dig.

Websites:

www.pipeline.nd.gov
www.northdakotapipelines.com

