State of the Oil Market: Around the World and Back to the DJ….in 25 Minutes

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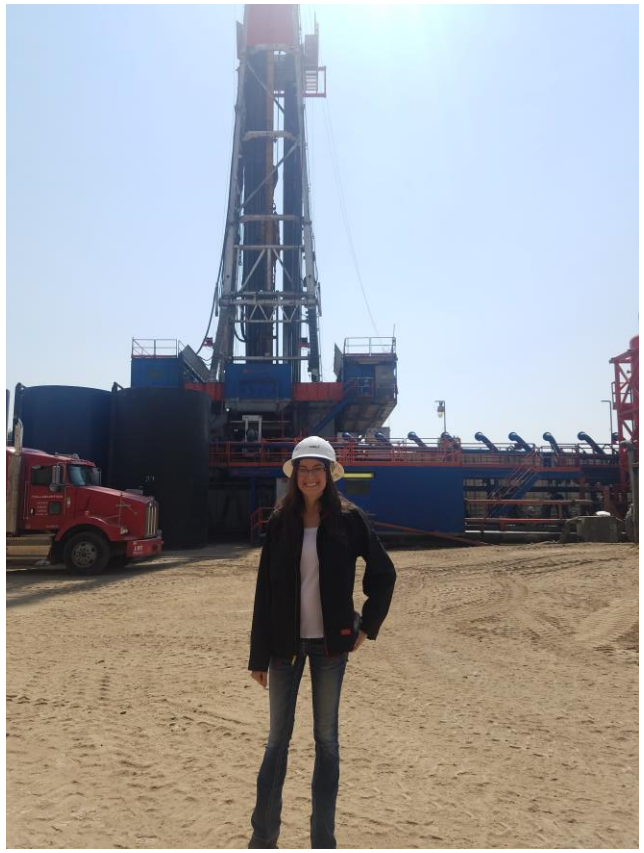
PetroNerd:



Source: Extraction rig, September 2017

- Boutique energy analytics and advisory firm based in Denver, CO
- Personalized, data-driven advisory services
- Evaluate the performance and asset quality of North American oil and natural gas shale resources, improve midstream and downstream market knowledge and understand the impact of market developments near and abroad
- HedgeAware - Interactive cloud-based solution for quickly assessing the hedging strategies and past performance of U.S. oil and gas producers on a single, easy to use platform

“Completion Design Changes and the Impact of US Shale Well Productivity”

November 2017

Completion Design Changes and the Impact on US Shale Well Productivity

I. Introduction

The 2014 oil price downturn caused the US unconventional oil and gas industry to undertake an array of cost-cutting measures affecting both capital and operational expenditures. Focus shifted towards operational efficiency, well design, and the maximization of each dollar spent, and away from the gold rush mentality that had characterized the former $100/b price environment. Perhaps counterintuitively, the emphasis on efficiency has helped to propel consecutive years of well productivity gains[1] across several shale plays. These gains have continued into 2017, even as the industry still grasps at profitability. This paper seeks to build on our previous work – including the 2016 OIES paper *Unravelling the US Shale Productivity Gains* – on well productivity gains. Specifically, it examines the continued productivity growth across multiple US shale plays and attempts to identify the factors contributing to this growth, as well as address some of the potential economic constraints.

Drilling, completing, and producing shale or tight oil and gas wells has always been both an art and a science. Over the past three years, in a sub-$60 oil price environment, this has never been more true. A combination of science, technological advancement, and brute force experimentation has led to broad productivity gains across the shale patch. In the long run, the shale industry will continue to improve well productivity, but in the short run, economic constraints could imperil productivity gains as operator profitability faces renewed scrutiny. But – geologically and technologically speaking – there is certainly room to grow.

We have interviewed engineers and technical experts from a wide range of industry fields over the past year to ascertain exactly what factors are driving increases in well productivity. The jury remains out. It is quite apparent that there are many known unknowns regarding sub-surface science, and the industry is actively trying to unlock these. There is much room to grow. Well productivity can and will continue to improve as these enigmas are solved.

Efficiencies have been found in nearly all stages of the drilling and completions process (although it has been the service companies who have borne the brunt of pricing concessions). One example is the reduction in spud to total depth times, coupled with increased drilling precision. The speed and cost at which wells are drilled, from spud to total depth, is a mere fraction of what it was in 2014. Bakken and Eagle Ford wells can be drilled in under a week. Some Denver Julesburg Basin wells are drilled in less than three days. Despite the more rapid pace, precision has improved.[2] Geosteering advances have

[1] ‘Productivity gains’ refers to increasing hydrocarbon output per well.
[2] EOG Resources’ comment on precision targeting in Q2 2017 earnings call reinforces this point: “*These latest Eagle Ford wells really demonstrate the impact that precision targeting makes on well performance. Successfully steering the lateral into the 10 or 20 feet of the highest quality pay of any given target can significantly enhance the well’s ability to achieve EOG’s premium drilling hurdle.*” EOG Resources, Q2 2017 Earnings Call, Seeking Alpha.

Energy Insight: 21

Trisha Curtis, Co-Founder Petronerds & OIES Research Associate and Benjamin Montalbano, Co-Founder Petronerds

Figure 15: Capex, free cash flow for 40 US-based E&P (million US$) and production (b/d)

urce: HedgeAware – By PetroNerds.

ere is a growing sense that the tide is finally turning; investors are now beginning to look for profits n these publicly traded operators, with the spotlight being on balance sheet stabilization, capital cipline, and ultimately free cash flow. How strong this investor sentiment is and will be over the next ple of quarters is not yet known. In 2015, the activist investor David Einhorn singled out Pioneer ural Resources as a ‘mother-fracker’, basically asserting that the industry was a Ponzi scheme and Texans were ‘*all hat and no cattle*’. Pioneer’s stock was impacted, but rebounded and has since n far more impacted by recent discussions around their gas-to-oil ratio (GOR). But lately more lysts have come out of the woodwork to discuss operator performance and free cash flow. This mer, an article in the *Wall Street Journal* aptly captured the dilemma with the title ‘Shale Produces Why Not Cash’. Later this summer, BHP Billiton agreed to step out of US shale entirely, due to ist pressure.[8]

ust recently, Schlumberger reiterated some concerns of US shale operators in its third quarter ngs call.

North America land where the E&P companies have added significant CapEx over the past year, the oduction growth is so far falling short of expectations, driven by supply chain inflation, operational fficiencies and the need to step out from the Tier 1 acreage. This has led to a moderating investment petite where the previous pursue to production growth is now being balanced out with an equal focus on nerated solid financial returns and operating within cash flow.

s moderation can be seen in the flattening trend of the U.S. land rig count during the third quarter and it is reflected in our customers’ 2018 activity outlook. The more tempered activity outlook for U.S. land mbined with the short cycle nature of the business has an immediate impact on the outlook for production with, which for 2017 and 2018 has been revised down by 100,000 and 500,000 barrels per day pectively. This clearly has a material impacts on the global supply and demand balance.

Schlumberger Q3 Earnings Call, Seeking Alpha, 20 October 2017.

ses to activist pressure to exit US shale’, Jamie Smyth, Hudson Lockett, and Pan Kwan Yuk, 21 August 2017, Times.

nts of this paper are the authors’ sole responsibility. They do not necessarily represent the views of the Oxford Institute for Energy Studies or any of its Members.

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http://www.petronerds.com/wp-content/uploads/2017/11/OIES-PetroNerds-Completion-Design-and-Productivity-2017.pdf

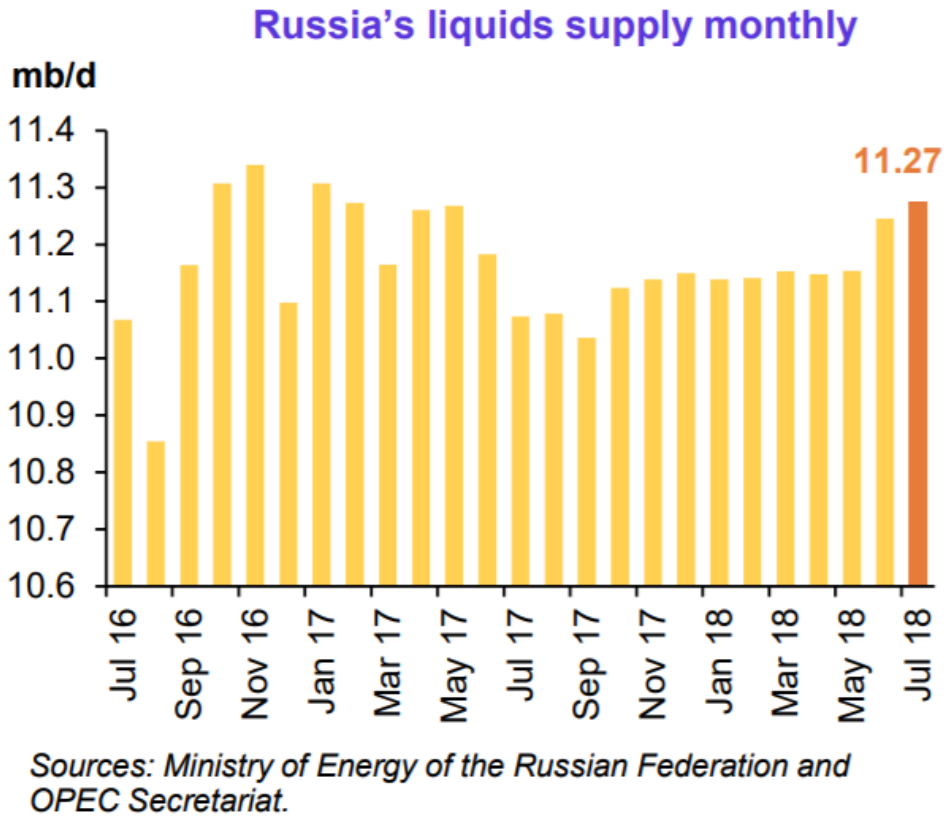
State of the Market

OPEC and Russian Production Edging Higher

OPEC crude oil production based on *secondary sources*, tb/d

	2016	2017	4Q17	1Q18	2Q18	May 18	Jun 18	Jul 18	Jul/Jun
Algeria	1,090	1,043	1,014	1,014	1,024	1,035	1,048	1,062	*13.8*
Angola	1,725	1,637	1,628	1,562	1,490	1,516	1,444	1,456	*11.7*
Congo	216	252	296	306	325	318	331	313	*-17.8*
Ecuador	545	530	525	515	519	520	521	525	*4.2*
Equatorial Guinea	160	133	129	134	127	129	126	126	*-0.3*
Gabon	221	200	199	195	188	187	191	188	*-3.4*
Iran, I.R.	3,515	3,811	3,822	3,813	3,813	3,822	3,793	3,737	*-56.3*
Iraq	4,392	4,446	4,401	4,441	4,476	4,461	4,532	4,556	*24.1*
Kuwait	2,853	2,708	2,704	2,704	2,708	2,703	2,713	2,791	*78.5*
Libya	390	817	967	991	889	962	721	664	*-56.7*
Nigeria	1,556	1,658	1,760	1,780	1,656	1,608	1,597	1,667	*70.5*
Qatar	656	607	604	593	601	602	612	616	*3.8*
Saudi Arabia	10,406	9,954	9,975	9,949	10,117	10,017	10,440	10,387	*-52.8*
UAE	2,979	2,915	2,892	2,850	2,873	2,862	2,890	2,959	*69.2*
Venezuela	2,154	1,911	1,762	1,538	1,382	1,388	1,325	1,278	*-47.7*
Total OPEC	**32,859**	**32,625**	**32,679**	**32,384**	**32,188**	**32,129**	**32,283**	**32,323**	***40.7***

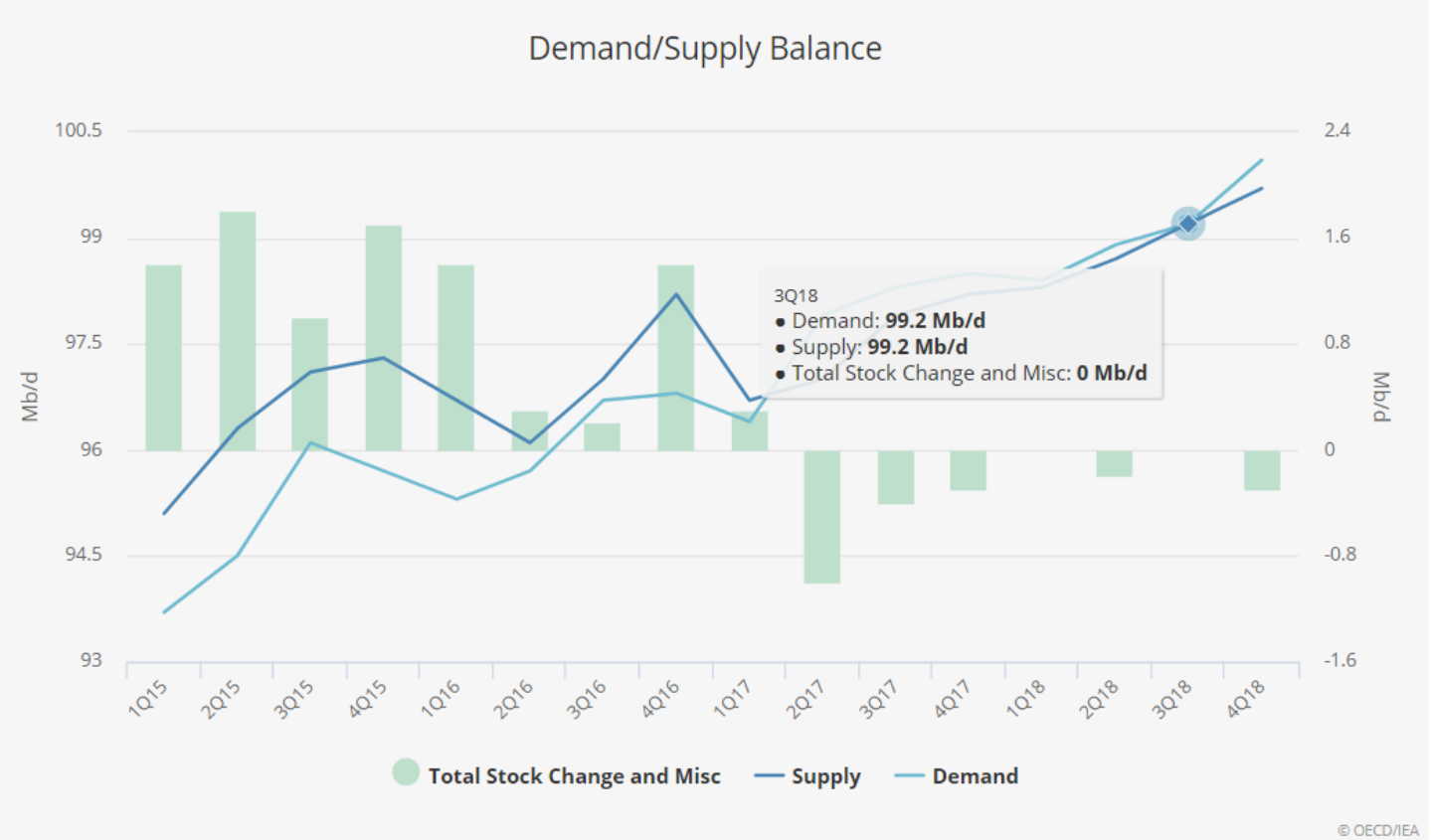
Notes: Totals may not add up due to independent rounding.
OPEC production figure includes the Republic of the Congo.
Source: OPEC Secretariat.



Sources: Ministry of Energy of the Russian Federation and OPEC Secretariat.

Source: OPEC

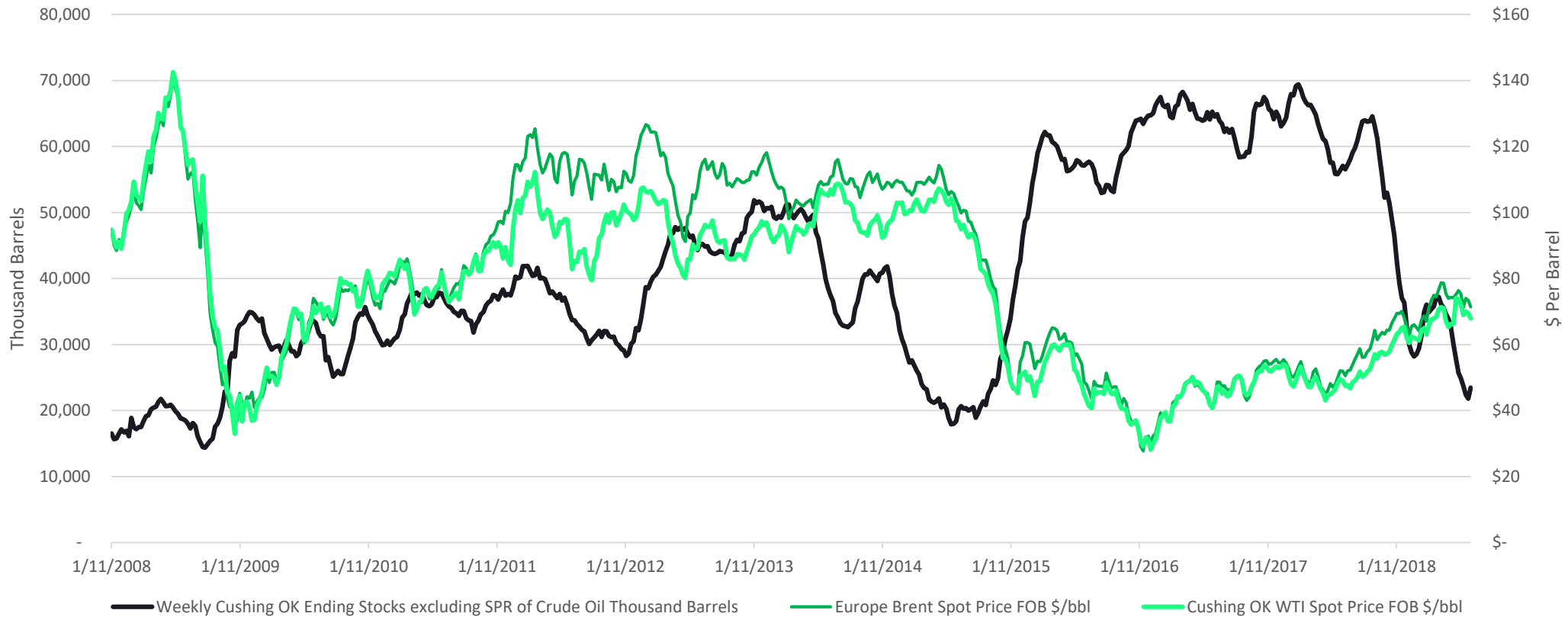
Supply and Demand



Perfectly balanced?

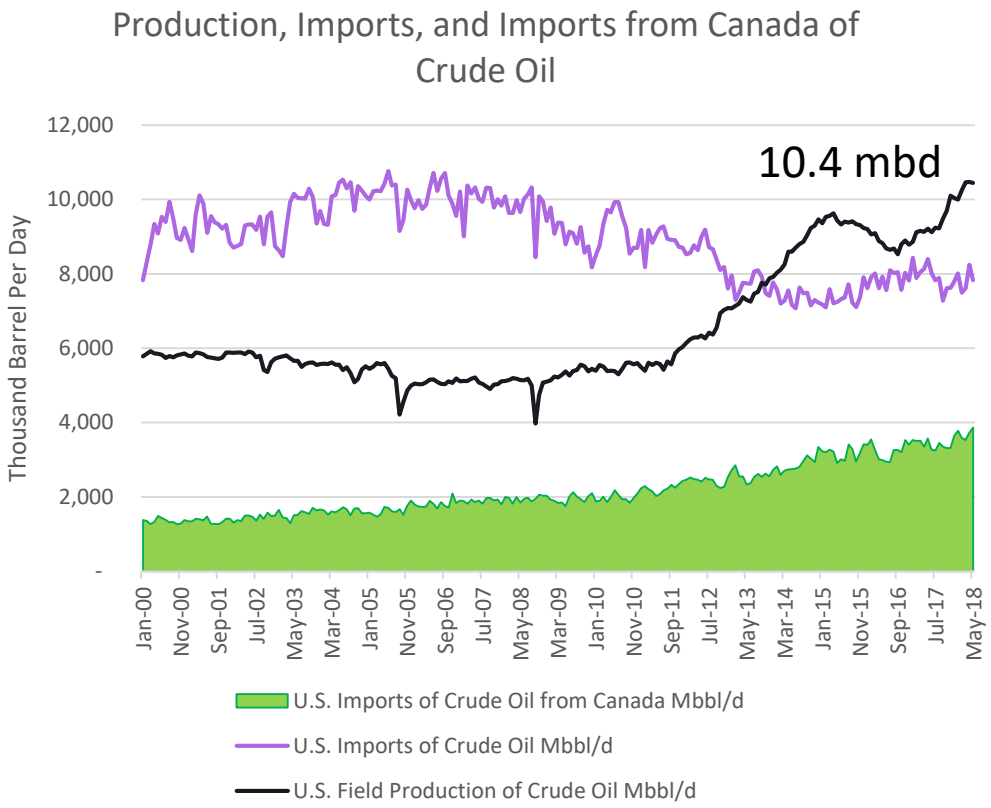
Source: IEA

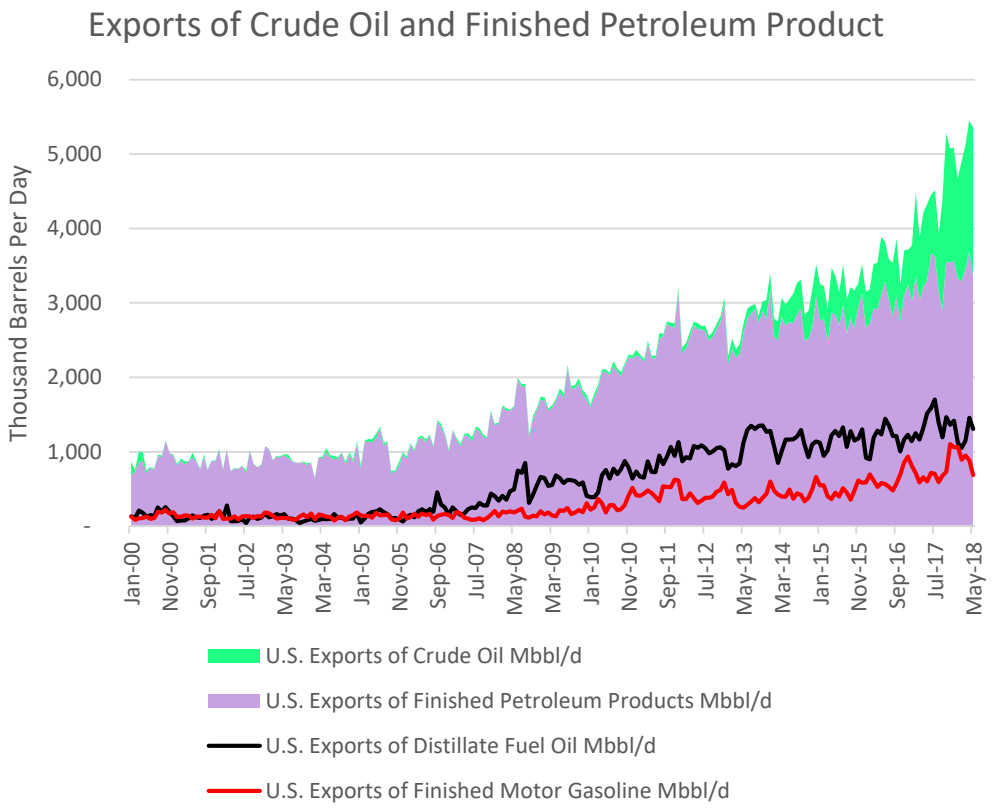
Cushing Inventories and WTI/Brent



Source: EIA

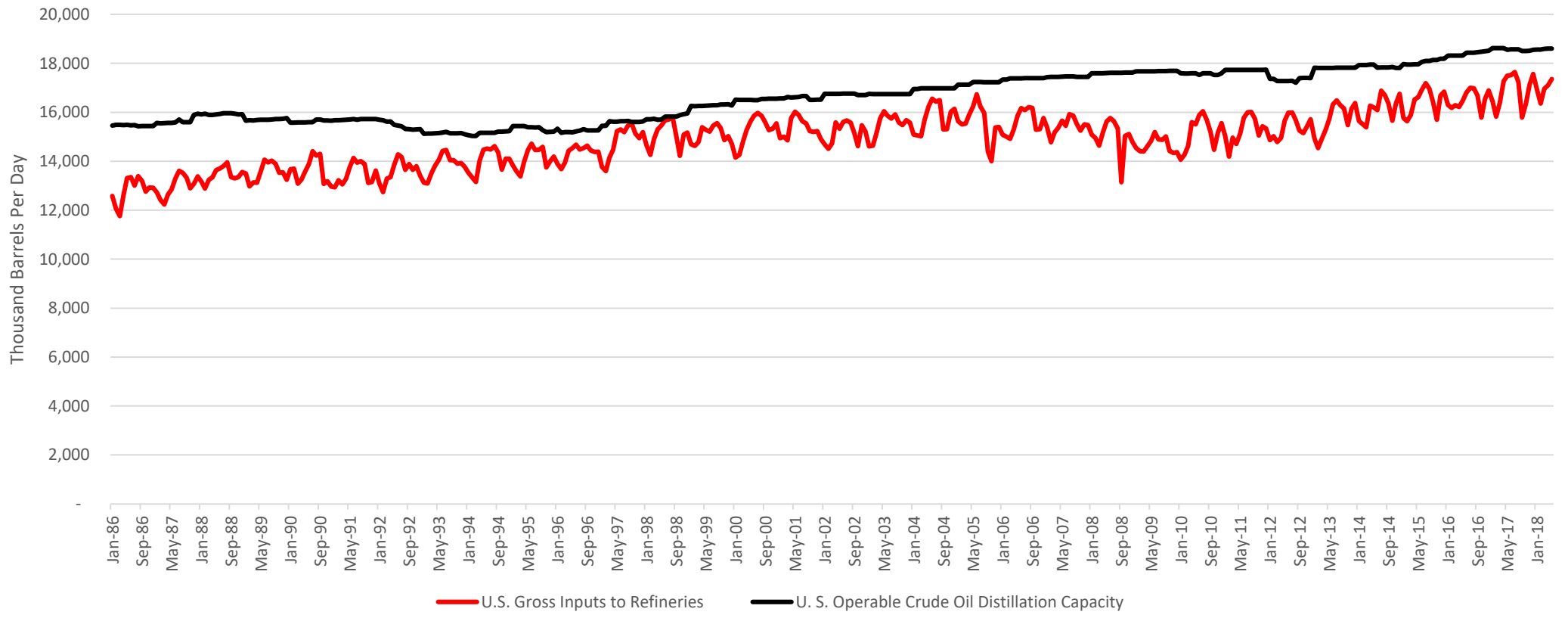
US Imports and Exports





Source: EIA

US Refinery Capacity and Gross Inputs



Source: EIA

China Trade Concerns

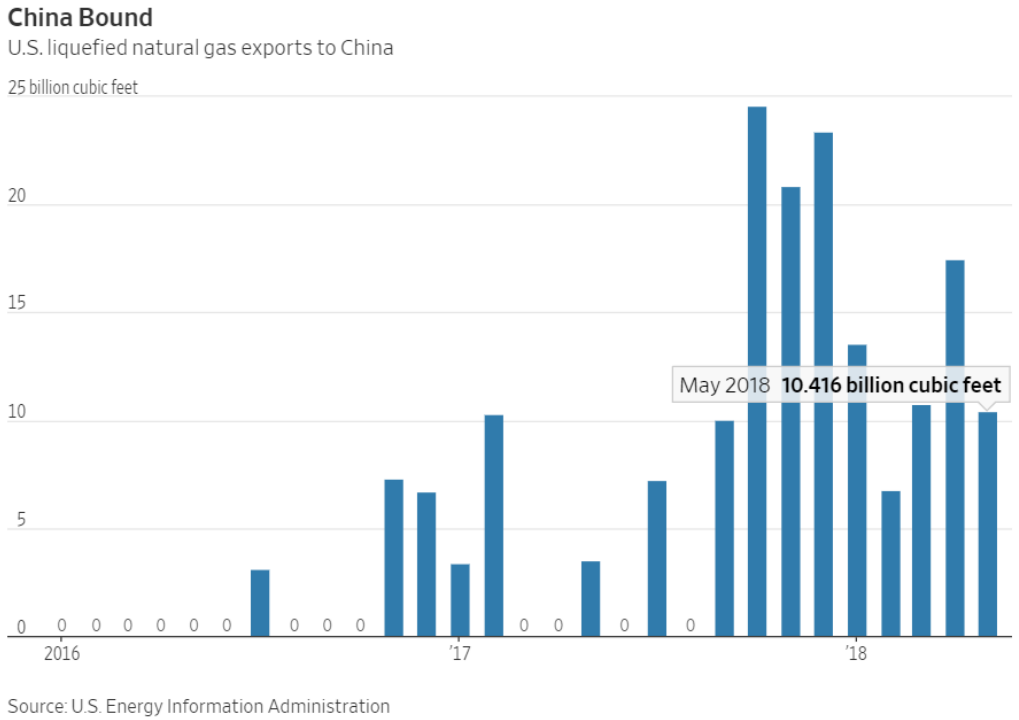
Trade Fears Throw Future of U.S. Natural Gas Into Question

As trade disputes continue, the promising U.S.-China energy relationship is compromised

A liquefied natural gas tanker ship at a Chinese terminal. Growing demand for LNG and unexpectedly fast growth in China in particular have been a boon for U.S. producers. PHOTO: -/AGENCE FRANCE-PRESSE/GETTY IMAGES

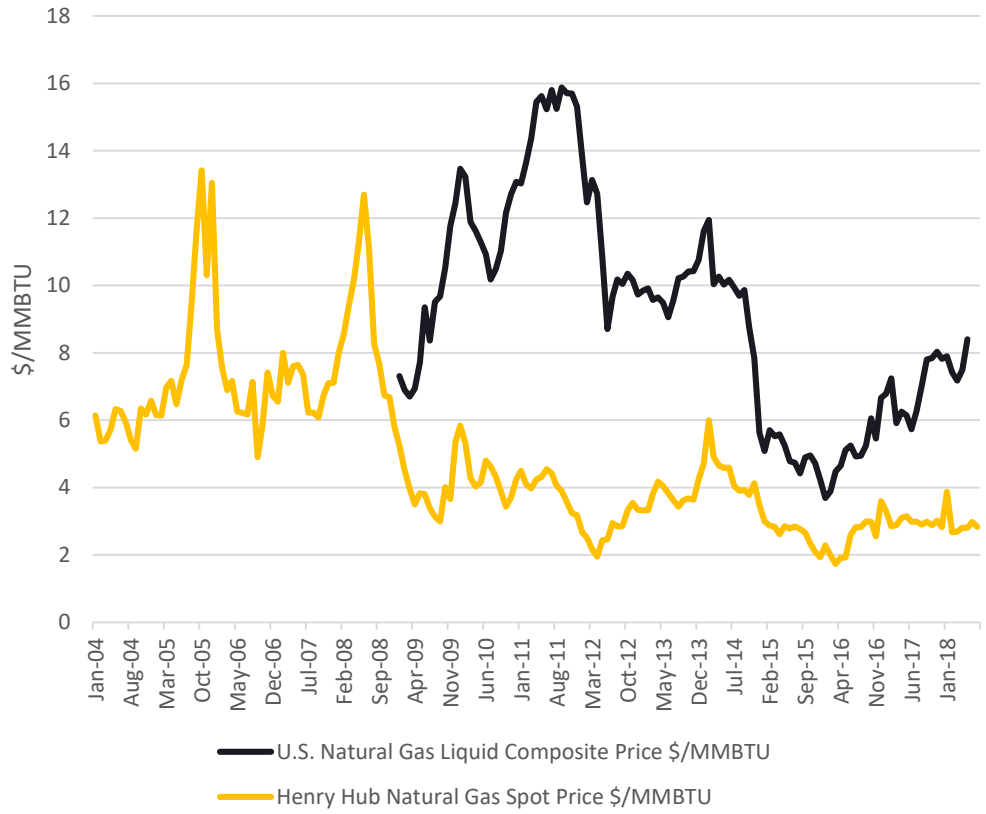
By Stephanie Yang and Timothy Puko

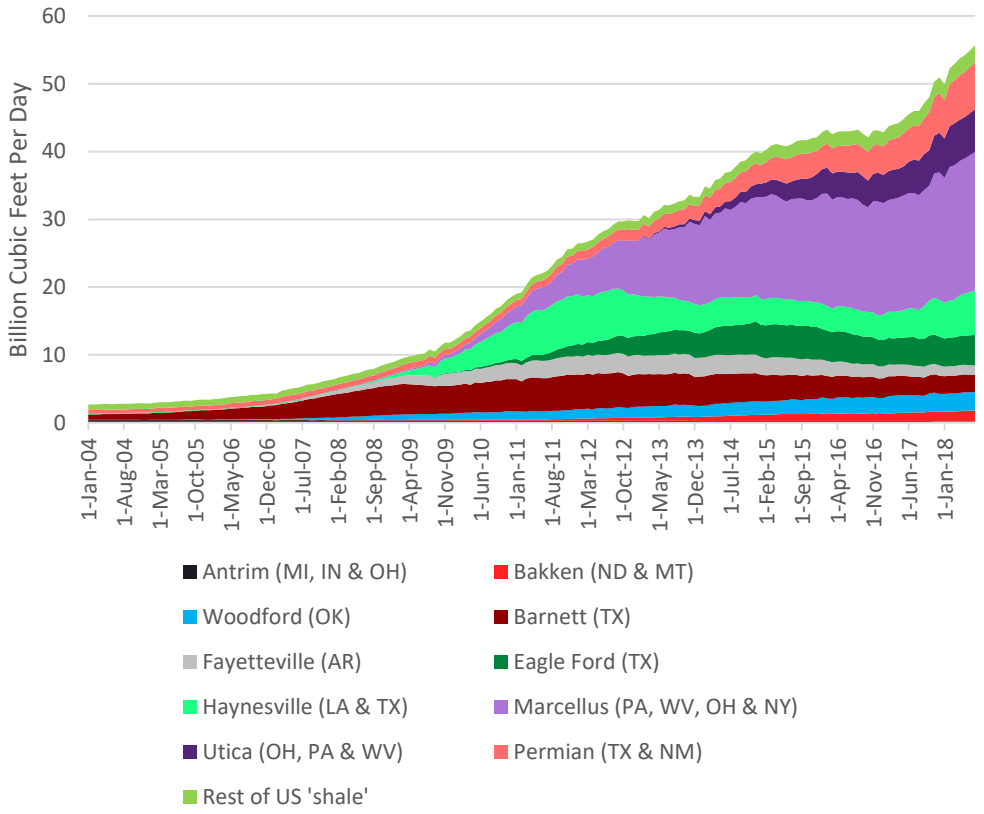
Aug. 17, 2018 7:00 a.m. ET



Source: EIA

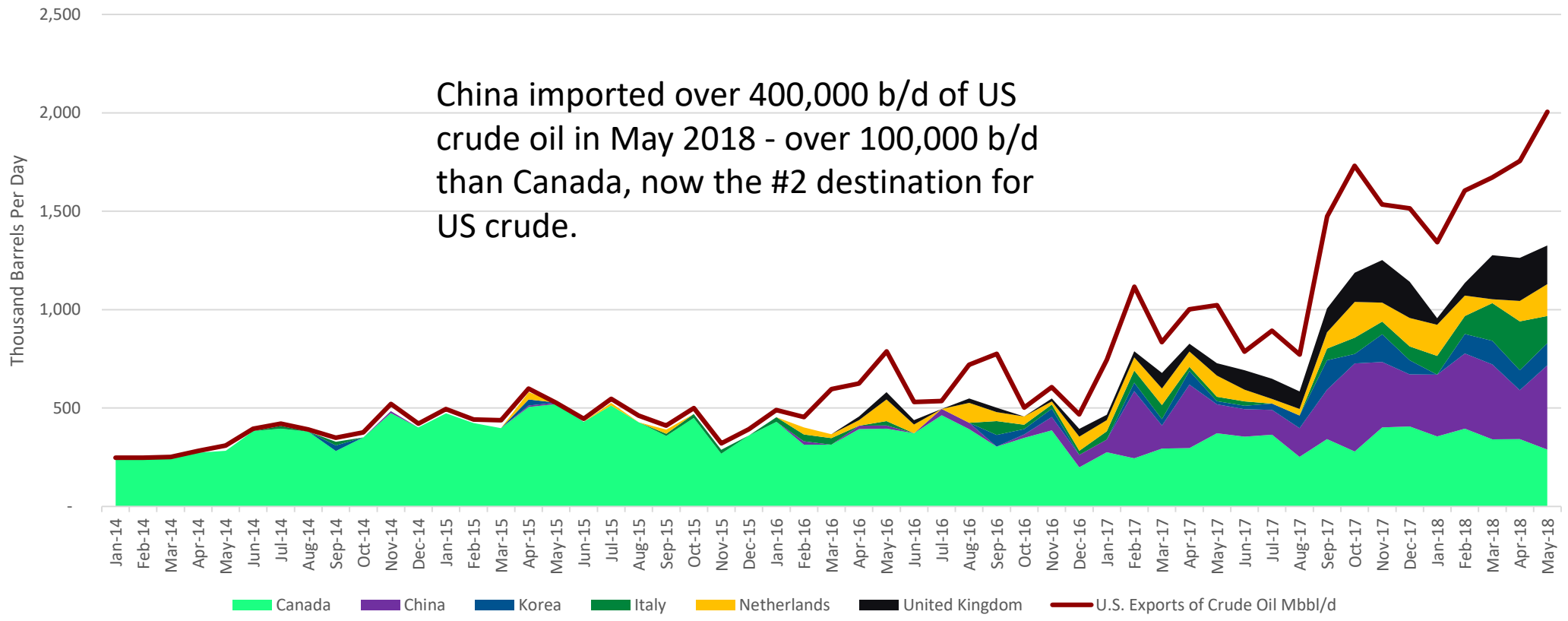
Gas Production and Prices





Source: EIA

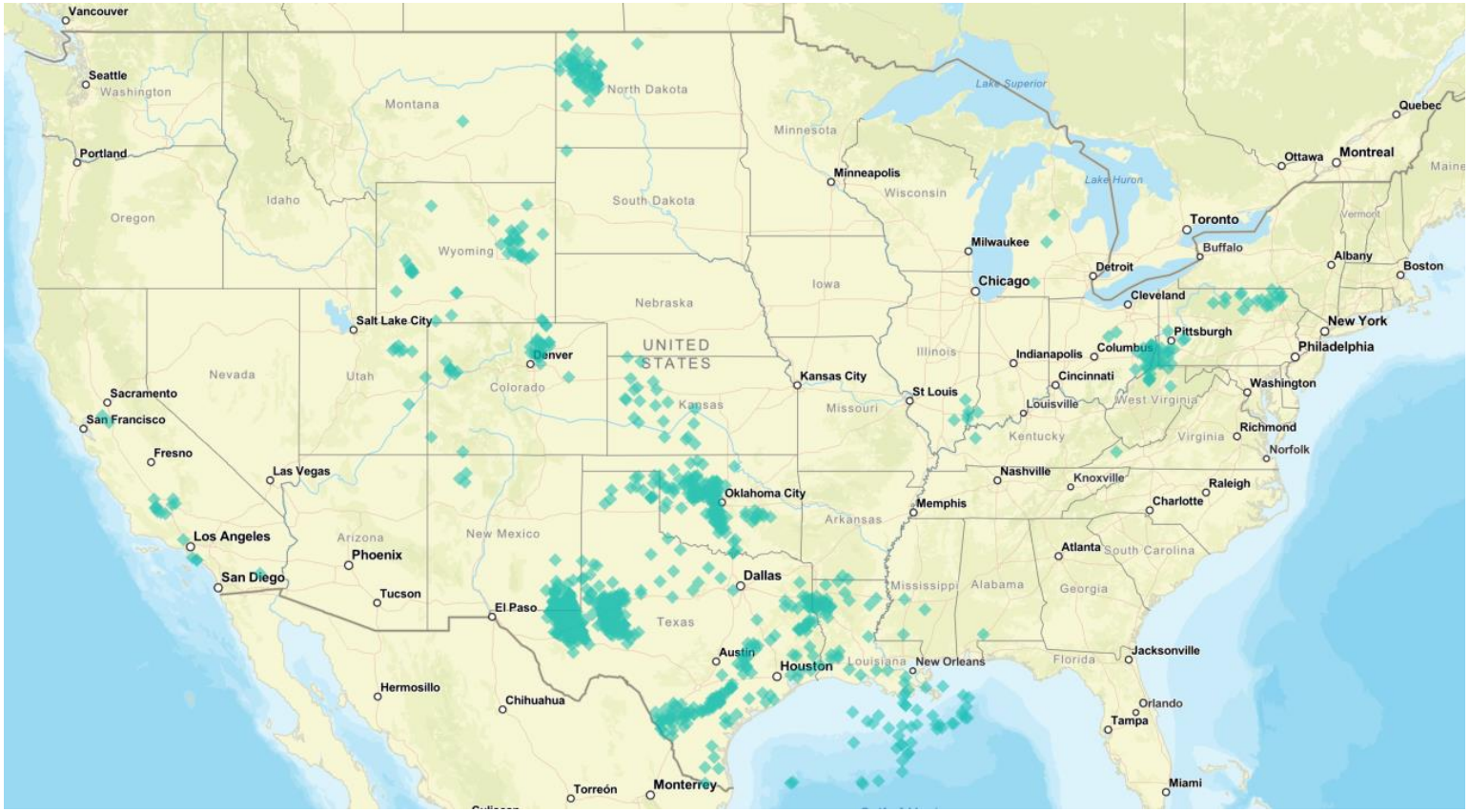
US Exports of Crude Oil



Source: EIA

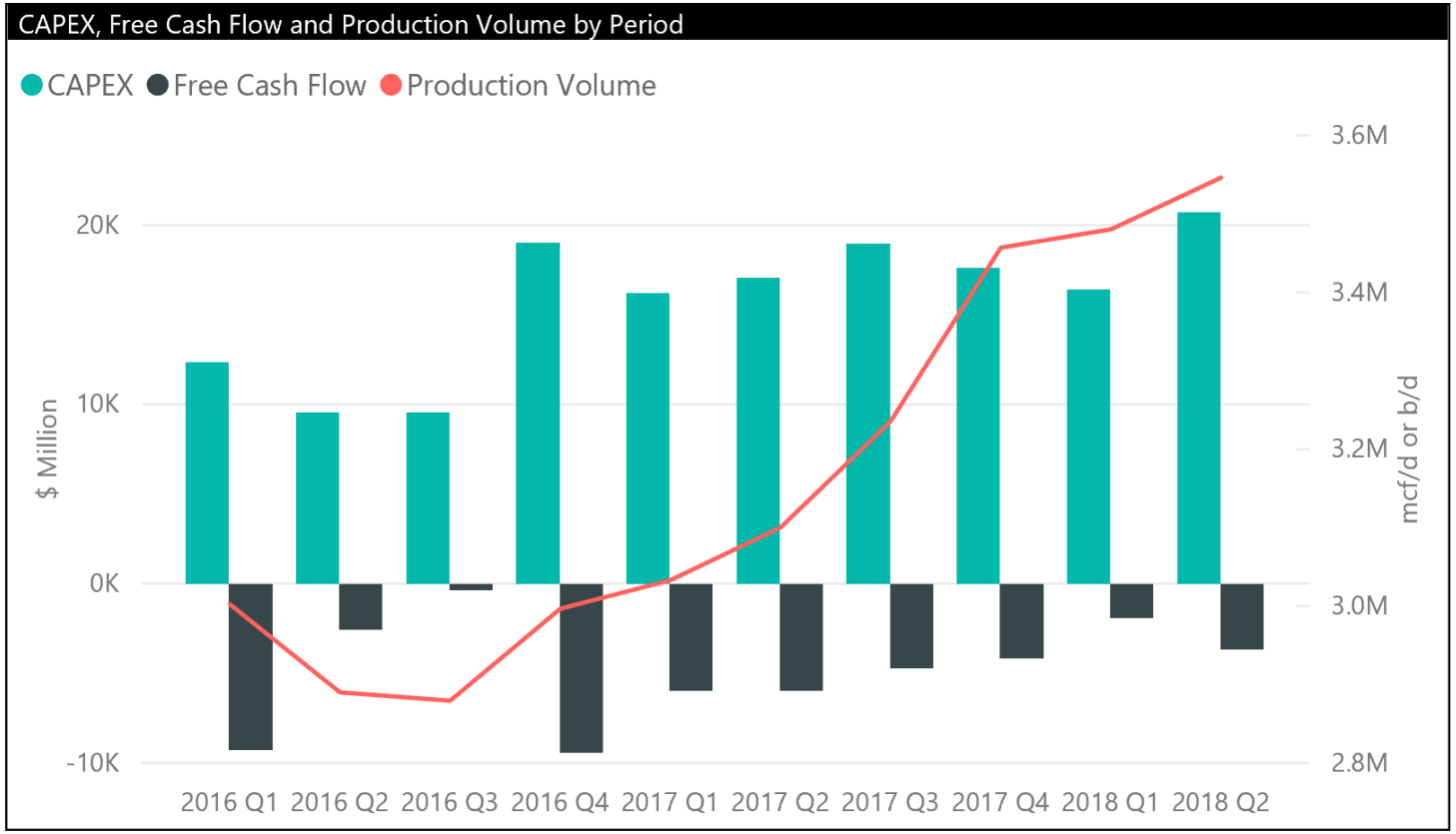
US Shalers

Active US Rigs



Source: PetroNerds, DrillingInfo

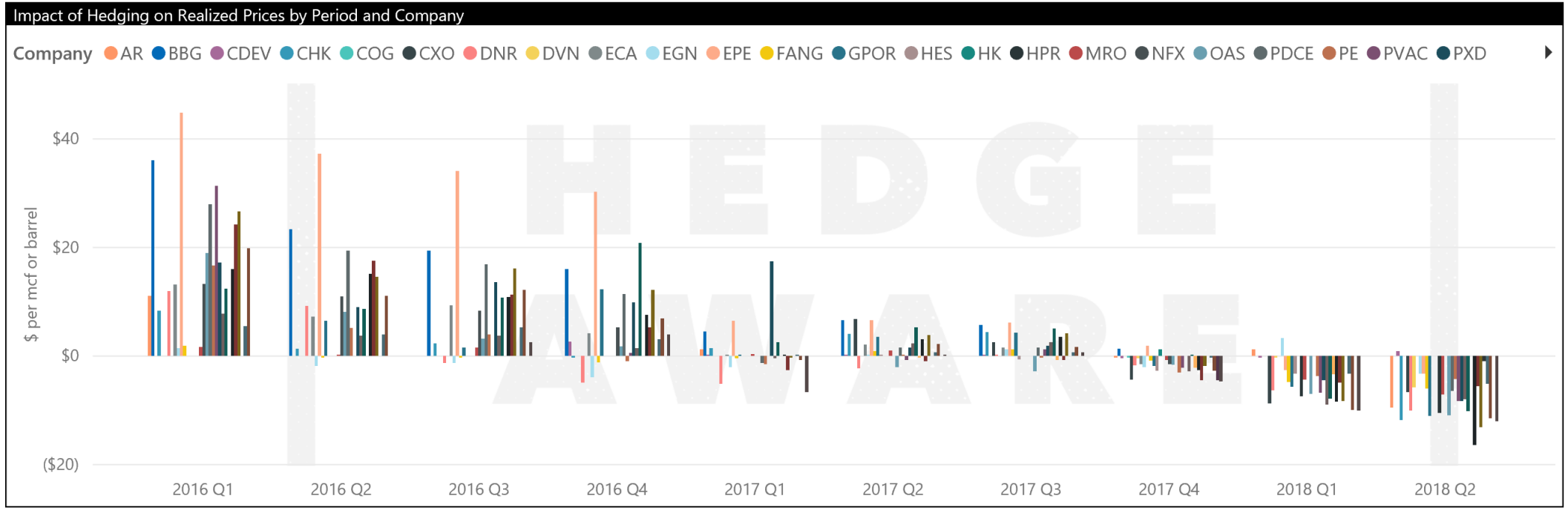
Industry Snapshot – FCF, Production, CAPEX



Source: HedgeAware, a PetroNerds Product

Hedges are Taking a Toll

In Q2 2018, underwater oil hedges reduced realized sales prices by approximately $8/b across 3 mm bd of production (reducing the aggregate revenue of 40 operators by $2.2 billion in Q2). Operators' swaps and collars remain below $60/b in Q3; expect these positions to reduce realized prices by about $5/b at $65/b oil.



Source: HedgeAware, a PetroNerds Product

Thinking About Investor Pressure

Wall Street Tells Frackers to Stop Counting Barrels, Start Making Profits

The shale-oil revolution produces lots of oil but not enough upside for investors

A drilling rig near Midland, Texas, in November. **PHOTO:** LUKE SHARRETT/BLOOMBERG NEWS

By Bradley Olson and Lynn Cook

Updated Dec. 13, 2017 6:09 p.m. ET

Frackers Burn Cash to Sustain U.S. Oil Boom

Many U.S. drillers have increased spending, but not production forecasts, pointing to possible slowdown

The drilling boom has increased demand for materials like sand and water that are used in hydraulic fracturing, driving up prices. **PHOTO:** CALLAGHAN O'HARE/BLOOMBERG NEWS

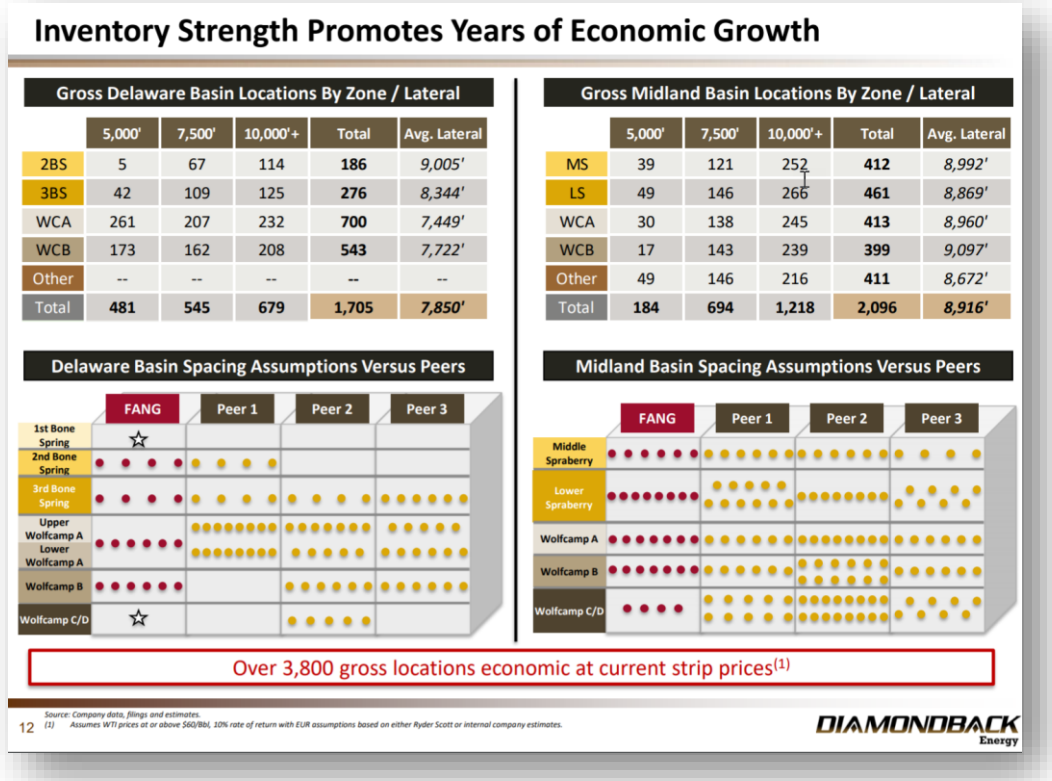
By Rebecca Elliott and Bradley Olson

Aug. 12, 2018 9:00 a.m. ET

Source: WSJ

Permian Complexity

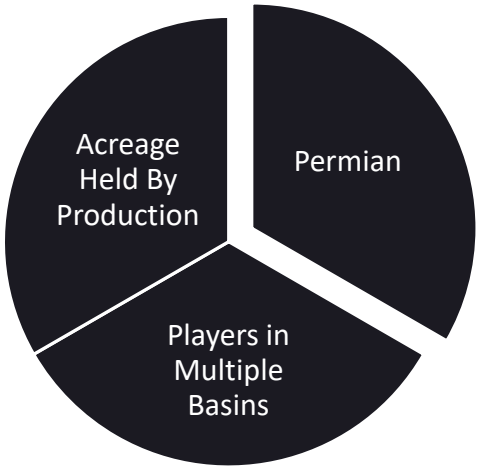
- Land rush, Wall Street push, and high acreage costs
- Now operators are trying to delineate, develop, and maintain leasing requirements all at the same time
- Tremendous stacked pay potential
- Successful development will require lots of work and capital
- Stringent leasing requirements in the Permian Basin often prevent optimal asset delineation
- INFRASTRUCTURE – Gas, Water, Oil
- MIDLAND Differential Blowouts
- GAS Constraints
- Optimal spacing and completion design (frac) is key
- Well density, inventory, parent child problems, all coming into focus



Source: Diamondback, April 2018 Investor Presentation

Pluses and Minuses for the Rockies

Assuming infrastructure availability in the Permian, capital in the Rockies will be competing with capital in the Permian Basin



DJ

- Positives: Delineated play, continued opportunities, lower cost
- Negatives: Infrastructure constraints, election, ballot initiatives, capital competition, investor pressure

Williston

- Positives: Delineated play, known geology, consistent crude quality, completion growth opportunities
- Negatives: Capital competition, Investor pressure

Powder

- Positives: Upside potential, stacked pay, few players
- Negatives: Delineation, few players, acreage sales, investor pressure, high cost

Schlumberger Comments

In North America land, we continue to deploy additional fracturing fleets during the second quarter, while pricing stayed flat as industry capacity additions matched the growth in customer activity.

…..the pressure on infrastructure and export pipeline capacity from the Permian Basin is becoming an increasing constraint to production growth, which will likely not be resolved until the second half of 2019.

…..production challenges linked in part to well interference as infill drilling in the producing acreage increases and as drilling continues to step out from the tier 1 acreage.

Source: Schlumberger, Q2 2018 Earnings Call

Steel Tariffs, Cash Flow, Gas, Labor Costs….

In addition, and in particular, we're now seeing the impacts of the steel tariffs flow through and they're affecting, of course, tubulars and other steel products that we use. We can see steel easily compared to last year would be 20% to 25% over last year's cost for the same products.

We're heading hopefully as quickly as possible towards a cash flow generative model…..

..we did secure firm transportation on Gulf Coast Express, the Kinder Morgan's pipeline. That is expected to come online early in Q4 2019, and at that point in time we'll have access to LNG exports….

….LOE is up slightly, really due to higher seasonal electricity costs for the quarter. We had a really hot May and June out in West Texas and that increased the demand and therefore pricing for electricity.

The other item is labor costs really driven by activity with higher oil prices that Tim talked about, and so we have seen some inflation on labor.

Source: Pioneer Natural Resources Q2 2018 Earnings Call

Noble – DJ vs. Delaware

Given the industry pressures in the Permian due to widening basin differentials and service cost inflation, we plan to moderate our activity in the Delaware Basin.

We will be reducing planned completions later this quarter and into 2019 to better align our activity with expected timing of pipeline additions. We will reallocate activity into our other onshore areas, primarily the DJ Basin.

The industry is seeing cost pressures given the higher price environment, particularly for drilling rigs, completion crews, steel and other services.

We've increased our full year capital budget to $3 billion, slightly above our prior range.

Anadarko – DJ vs. Delaware

Daniel E. Brown - Anadarko Petroleum Corp.

Thanks, Mike. This is Danny. Yeah. So, the service cost inflation for us, it's – from a Permian perspective, we haven't seen a whole lot. Now, recognize that we saw a tremendous amount of inflation in the basin over the course of 2017. And so, we were starting from a pretty high mark. On individual line items, we've certainly seen some inflation and some deflation. And so, when you run it across, it's maybe slightly up, but not much. We've seen a little bit of inflation in the DJ Basin, really relative to stimulation services, and some of the quiet fleets that are out there from a completion crew standpoint. But again, ups and downs in that. I'd say the most significant one is in stimulation and from a Delaware standpoint, really ups and downs and just maybe slightly, slightly up overall but generally flat.

Welles Fitzpatrick - SunTrust Robinson Humphrey, Inc.

Okay. And just wondering I guess along those lines, did the service costs that you saw in the DJ or any changes in the political environment there play a role in your decision to trim activity relative to what you had originally planned?

Robert A. Walker - Anadarko Petroleum Corp.

No. I wouldn't say that by any means. I mean, if anything, you might take just the opposite of that. If we were concerned about it, we would push the capital forward and not wait.

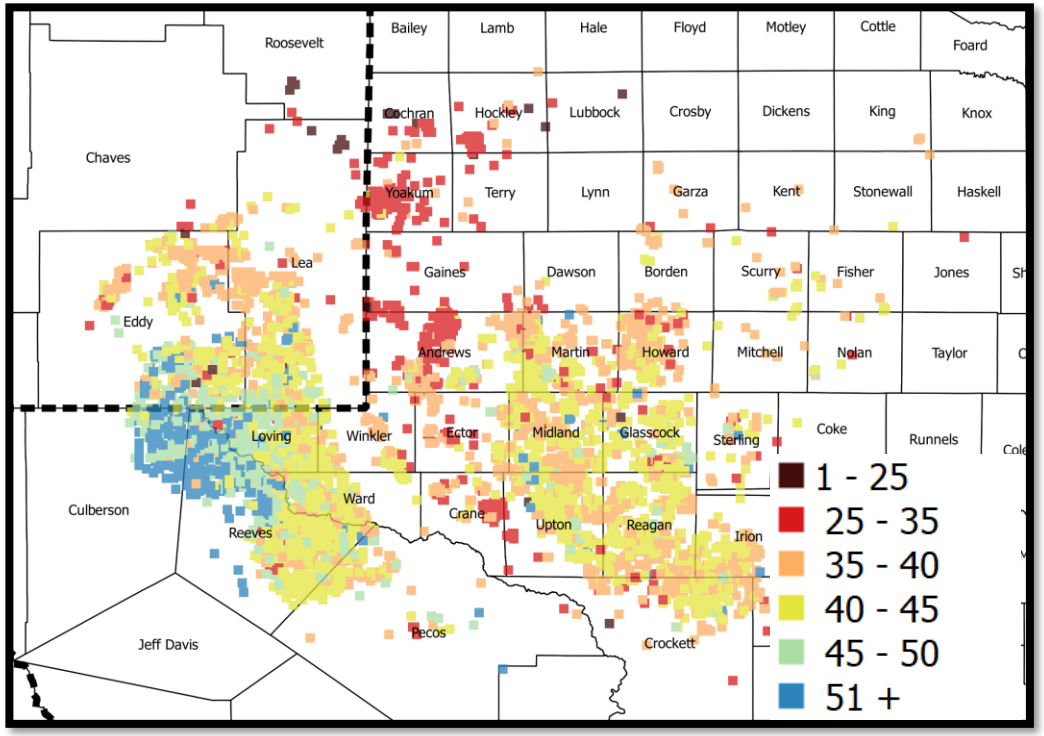
Daniel E. Brown - Anadarko Petroleum Corp.

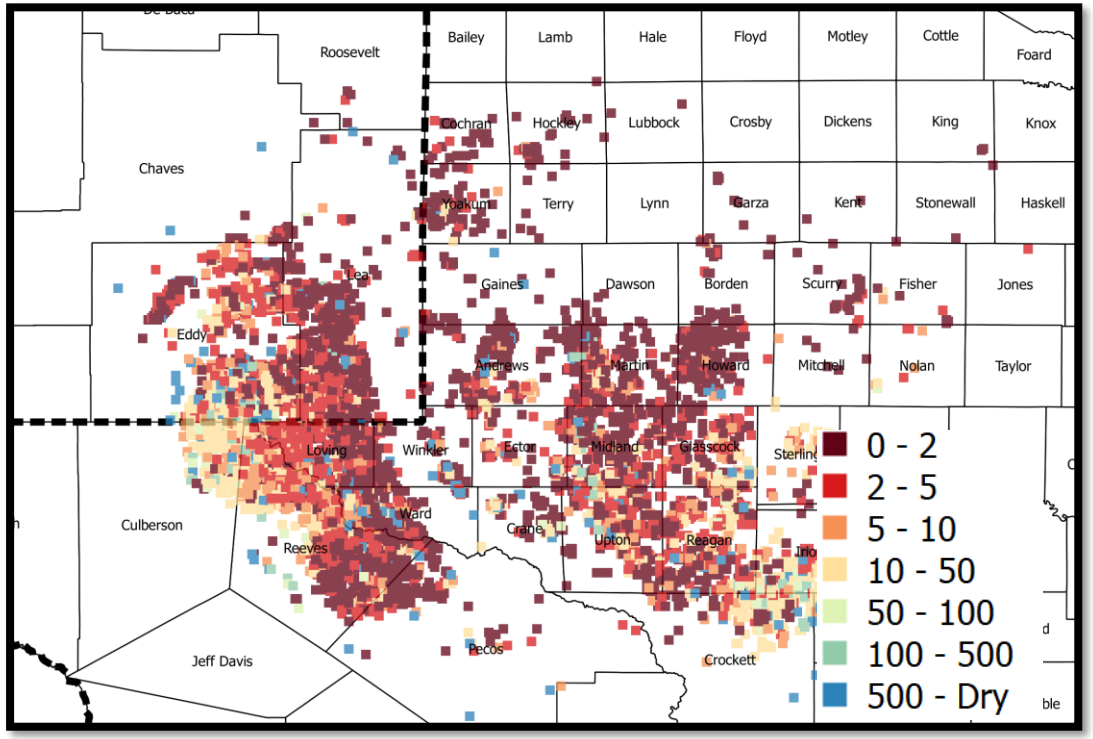
So, from a Delaware standpoint, we've communicated previously we've got around $8 million is what we expect per copy once we're in the development mode. We're higher than that now, as we've communicated. It's closer to $10 million. As we think about DJ, it's I'd say sort of tilted to (19:38) $3 million but it depends on the lateral length. And so, the longer wells obviously cost you more, the shorter wells are a little bit less. But think of it as around $3 million.

The Permian Basin

PRODUCTION, PROBLEMS, AND PRODUCTIVITY

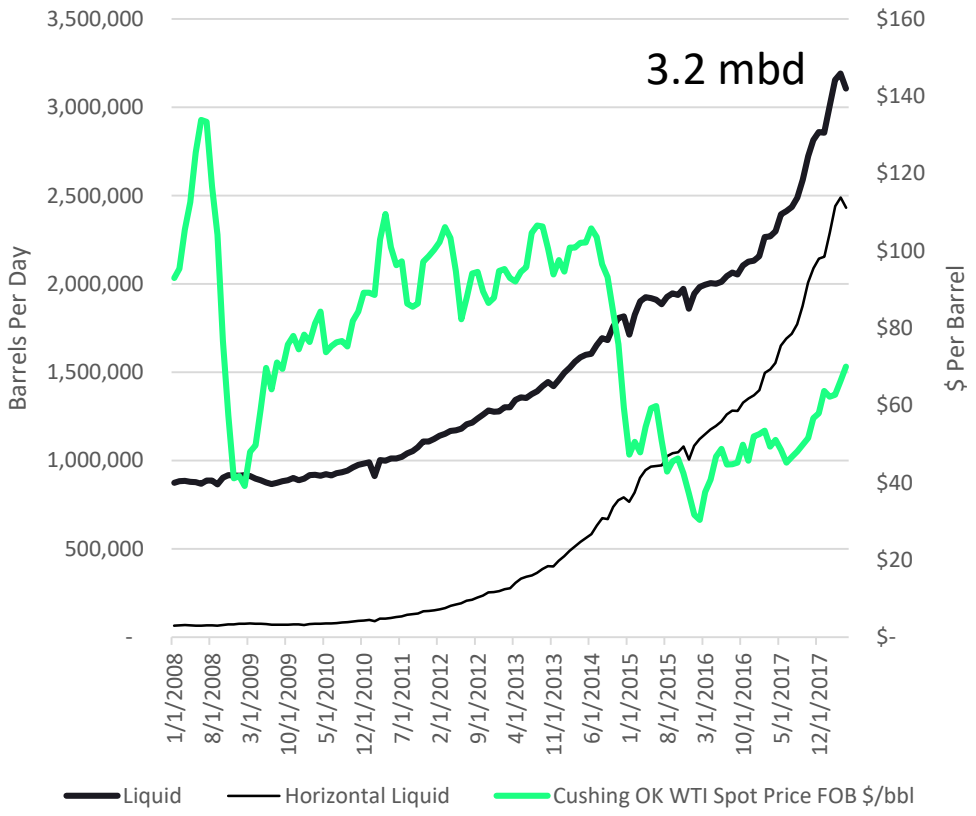
Permian Basin API Gravity and GOR

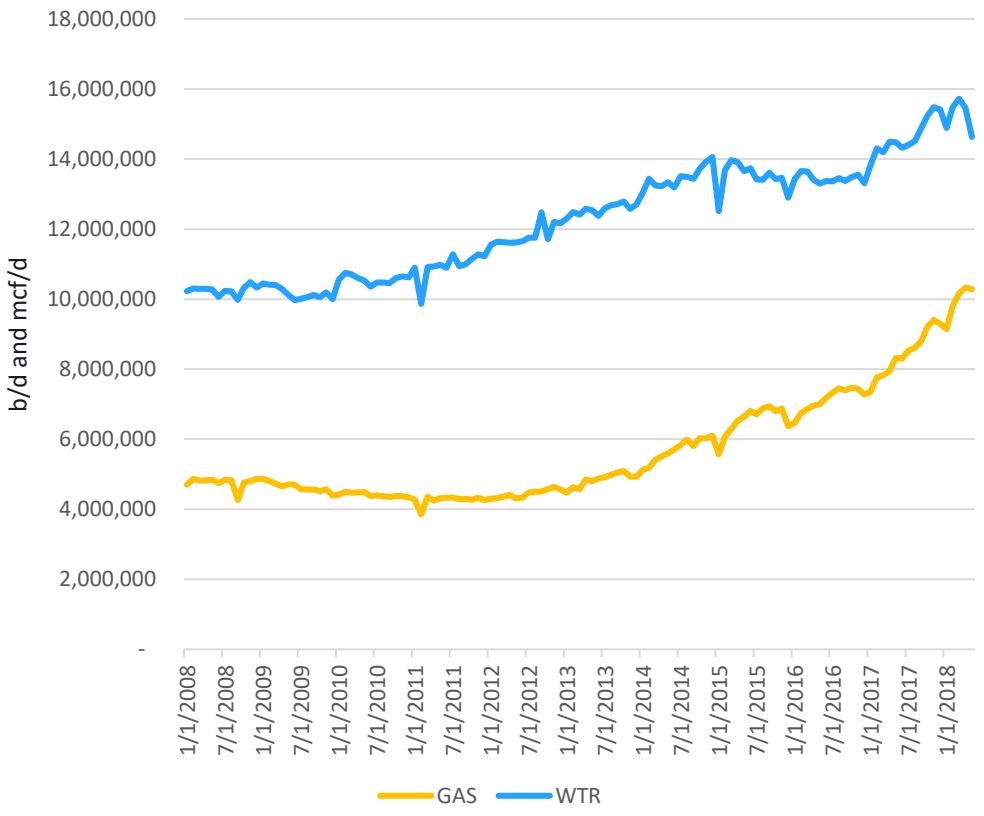




Source: PetroNerds, DrillingInfo

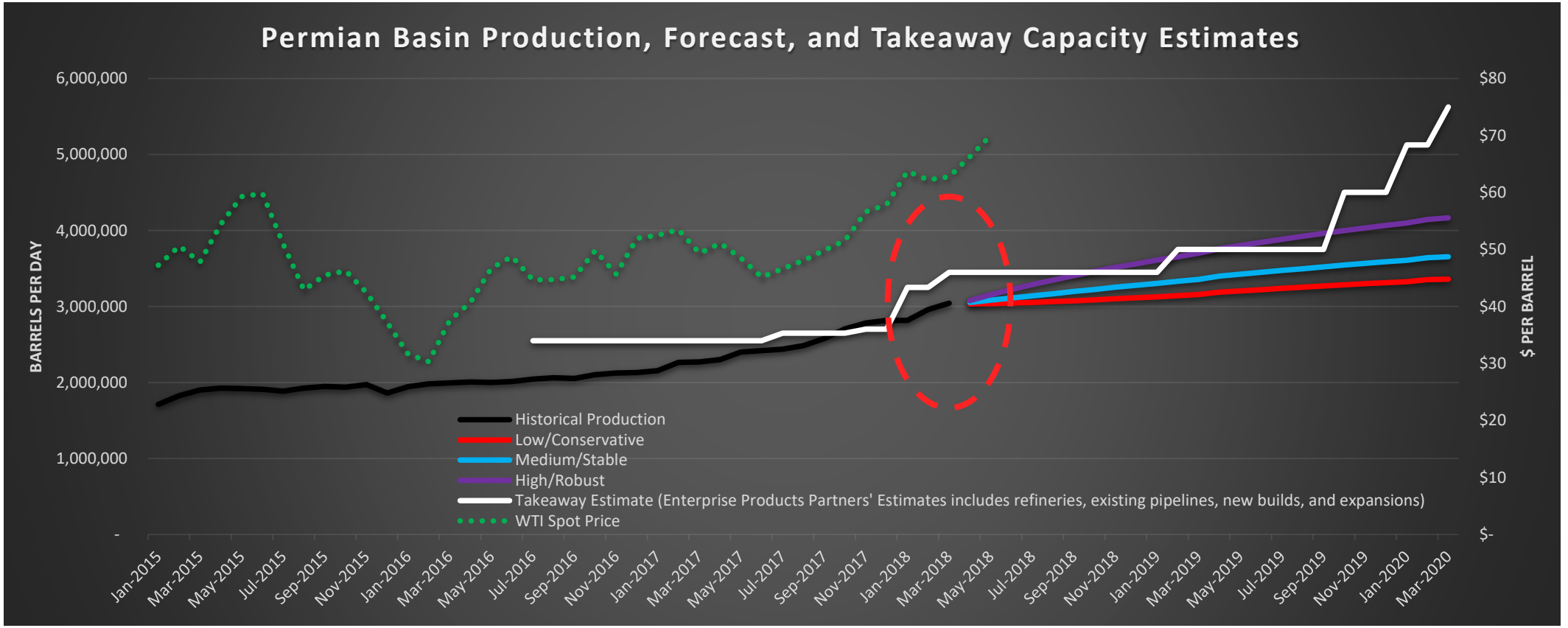
Permian Basin Production





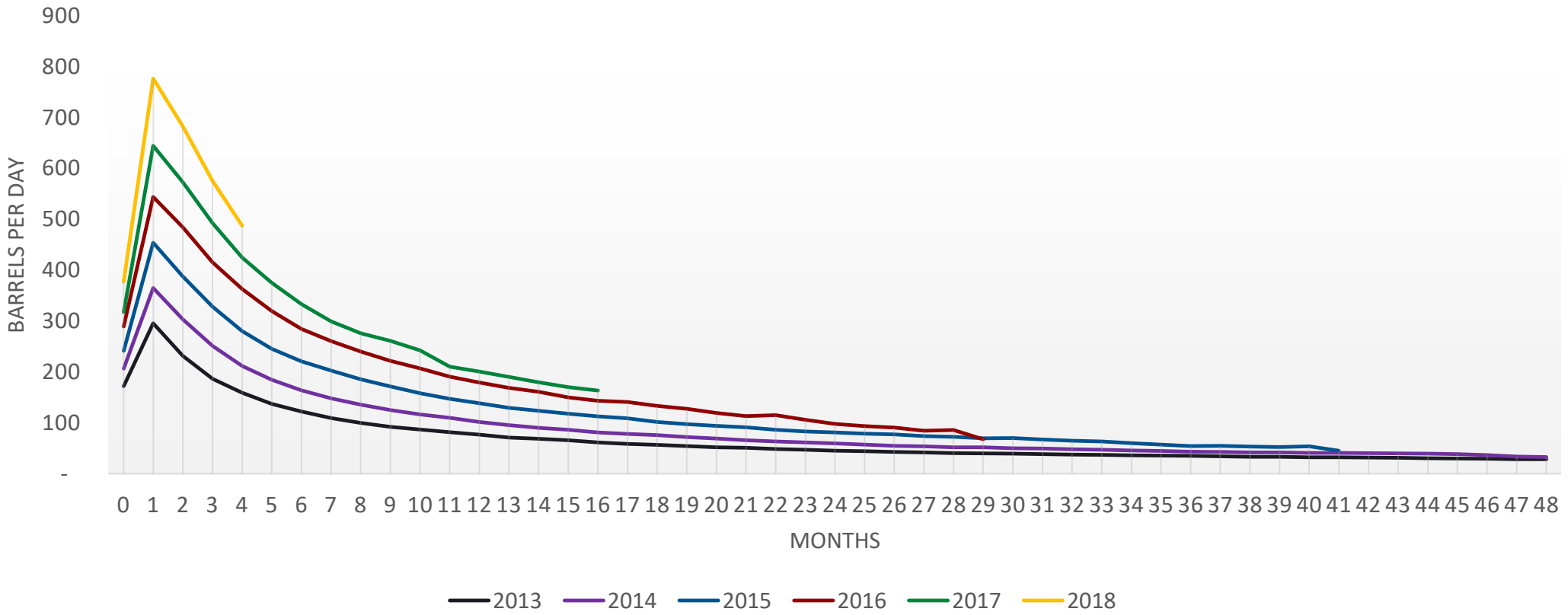
Source: PetroNerds, DrillingInfo

Permian Takeaway Capacity Estimate



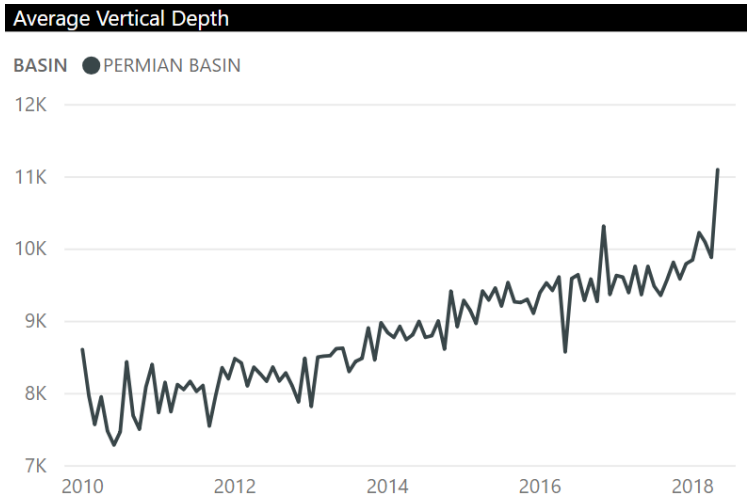
Source: PetroNerds, DrillingInfo, EIA, estimates from Enterprise Products Partners

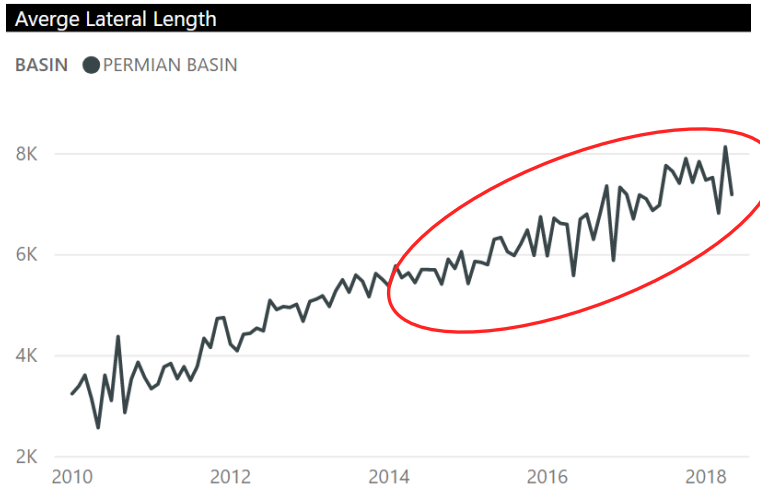
Permian Basin Horizontal Type Curve

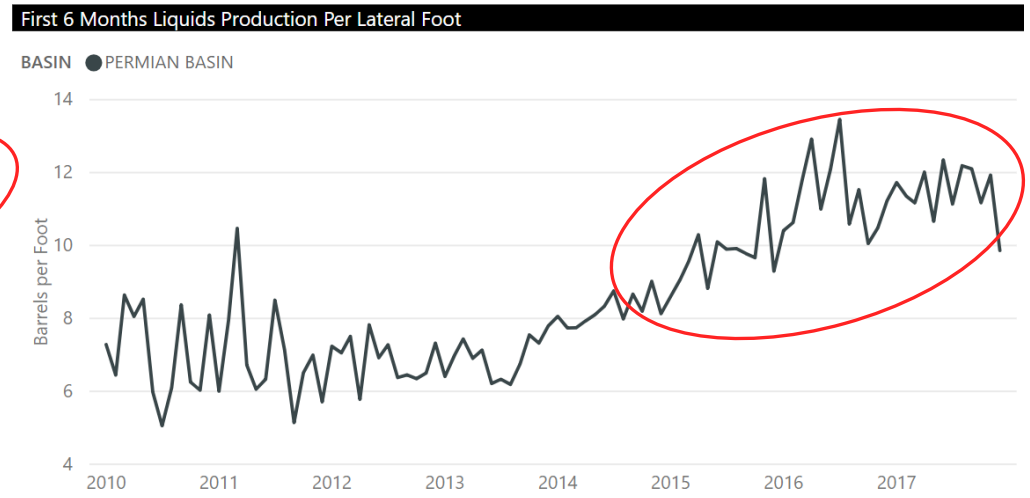


Source: PetroNerds, DrillingInfo

Permian Basin Productivity





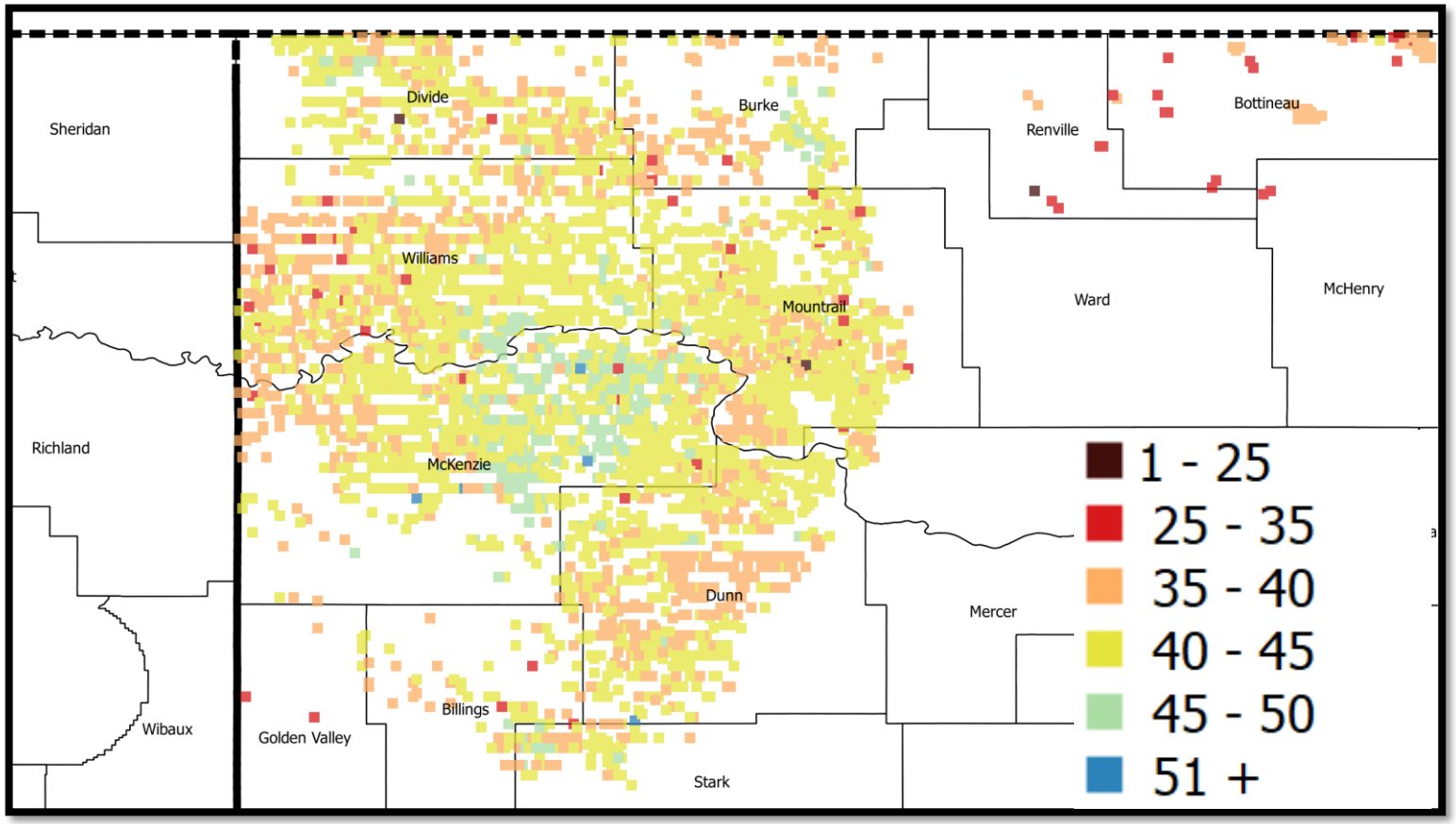


Source: PetroNerds, DrillingInfo

The Bakken

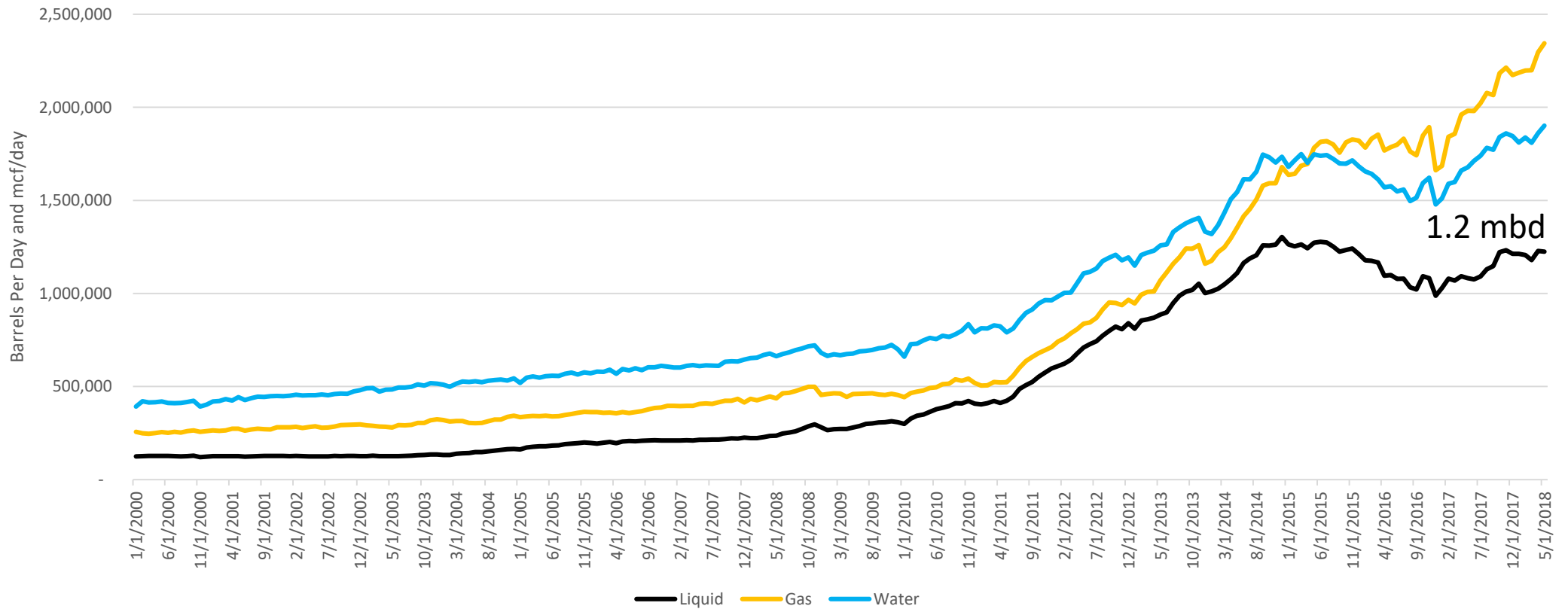
WILLISTON BASIN

Williston Basin API Gravity



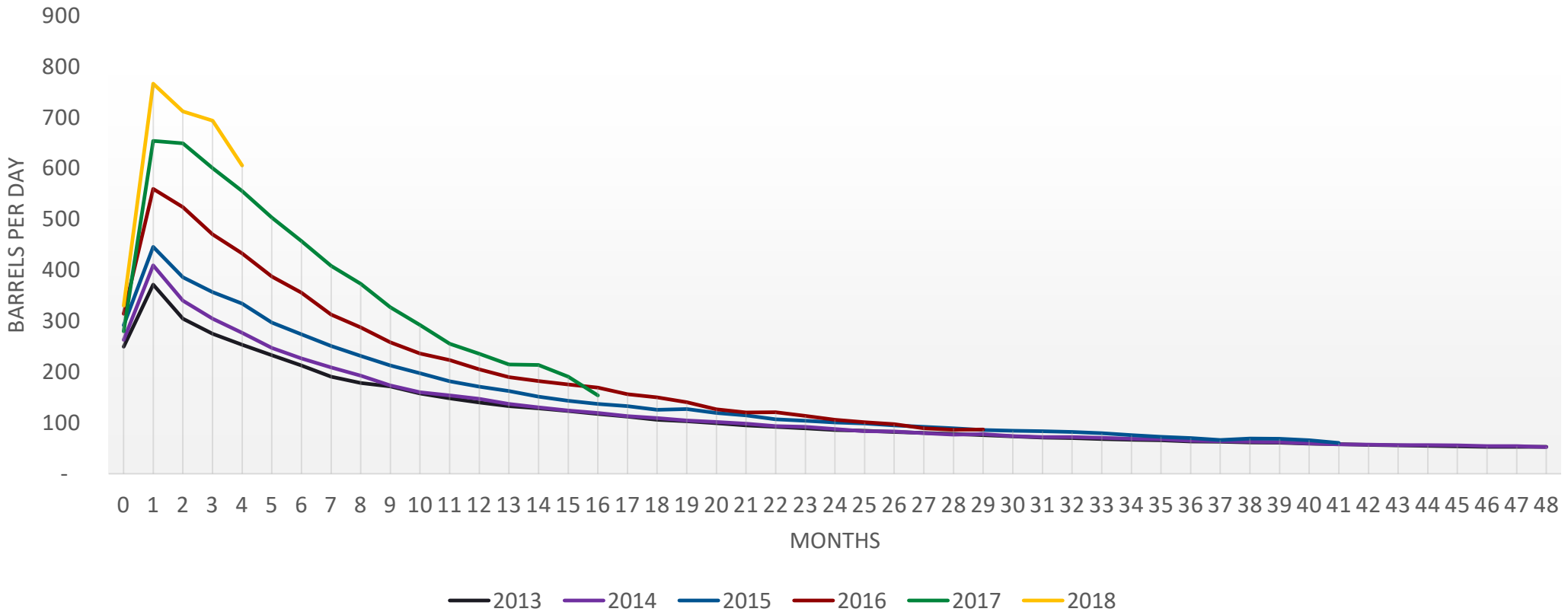
Source: PetroNerds, DrillingInfo

Williston Basin Production



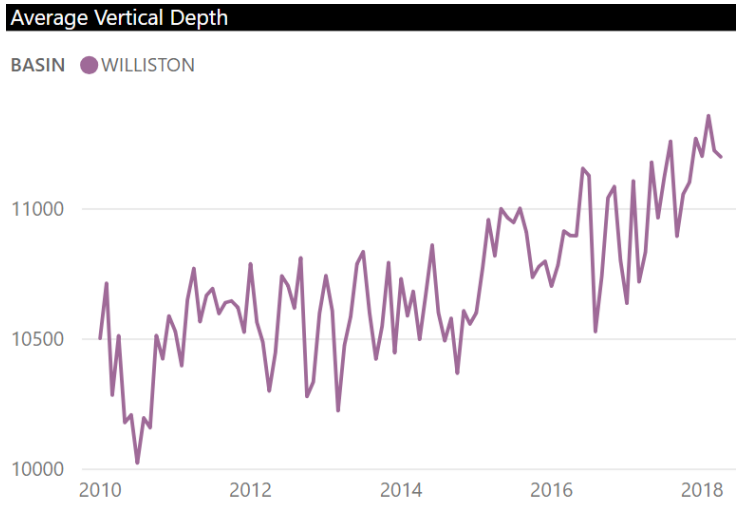
Source: PetroNerds, DrillingInfo

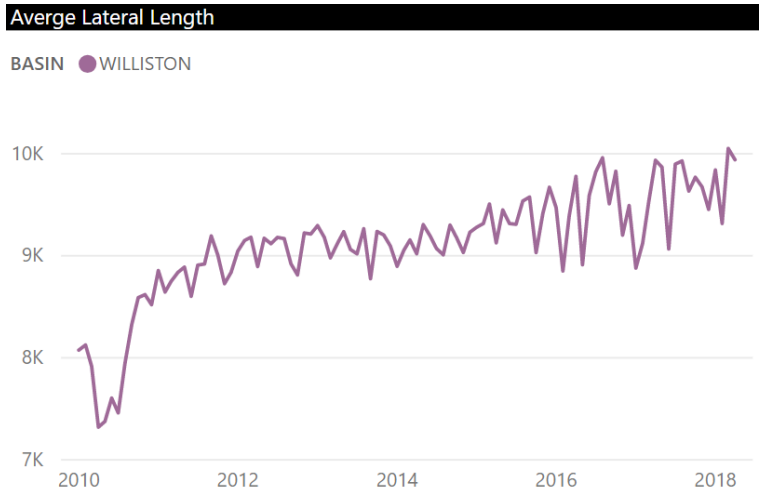
Williston Horizontal Type Curve

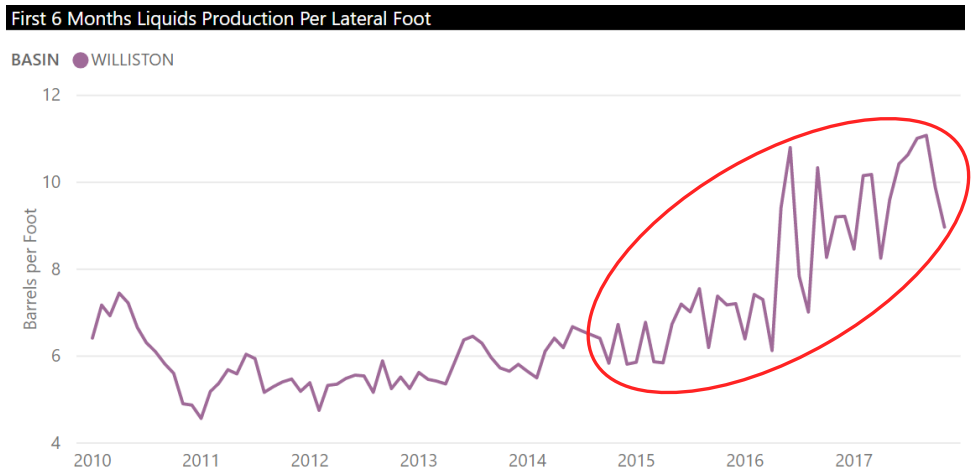


Source: PetroNerds, DrillingInfo

Bakken Productivity

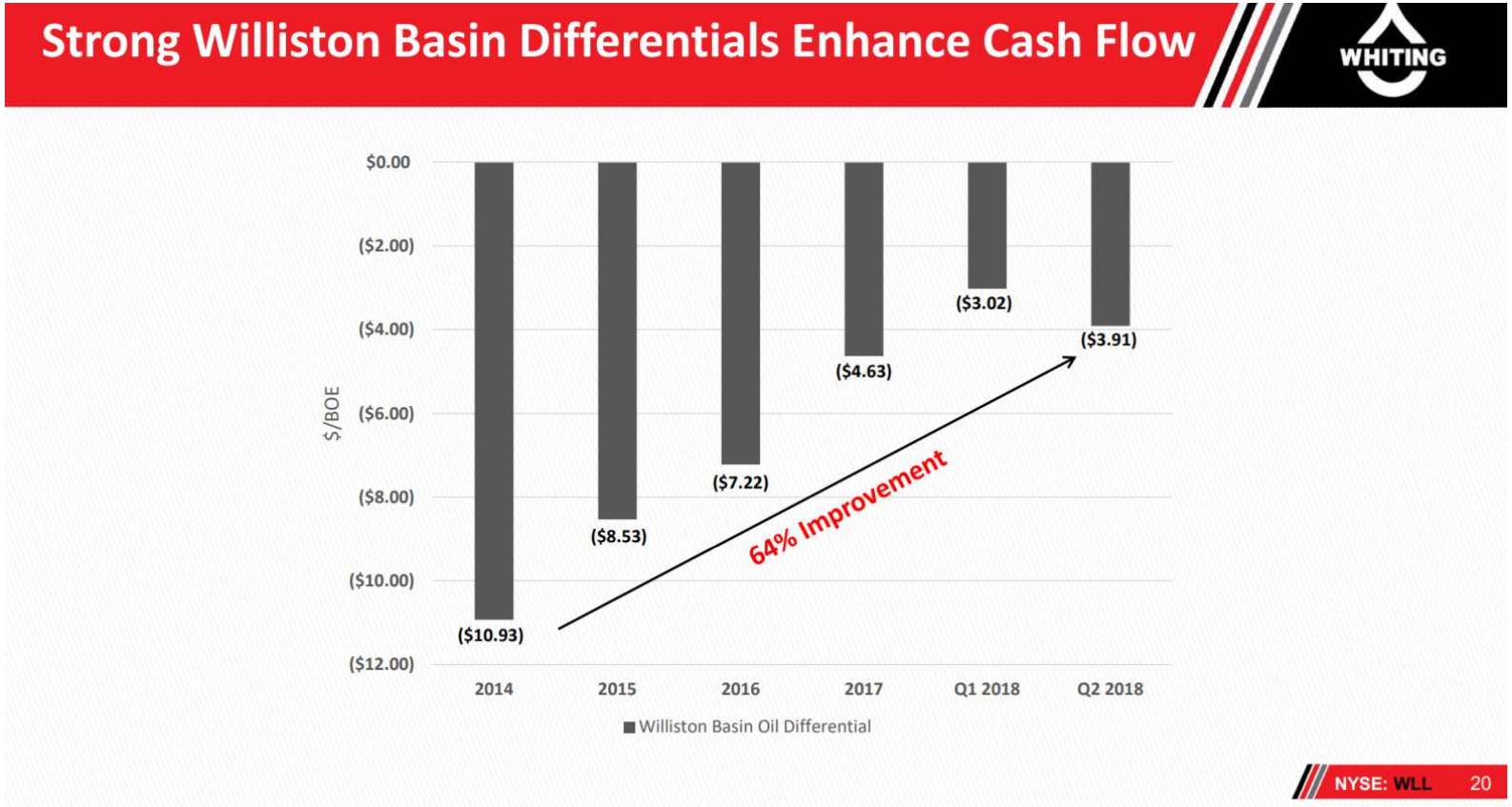






Production has increased on a barrels per lateral foot basis over the past two years. Lateral lengths are relatively unchanged. This means that completion design changes, likely the use of more proppant+fluid and more perforations, are contributing to better well performance.

The Differential – Allowing the Bakken to Compete Again

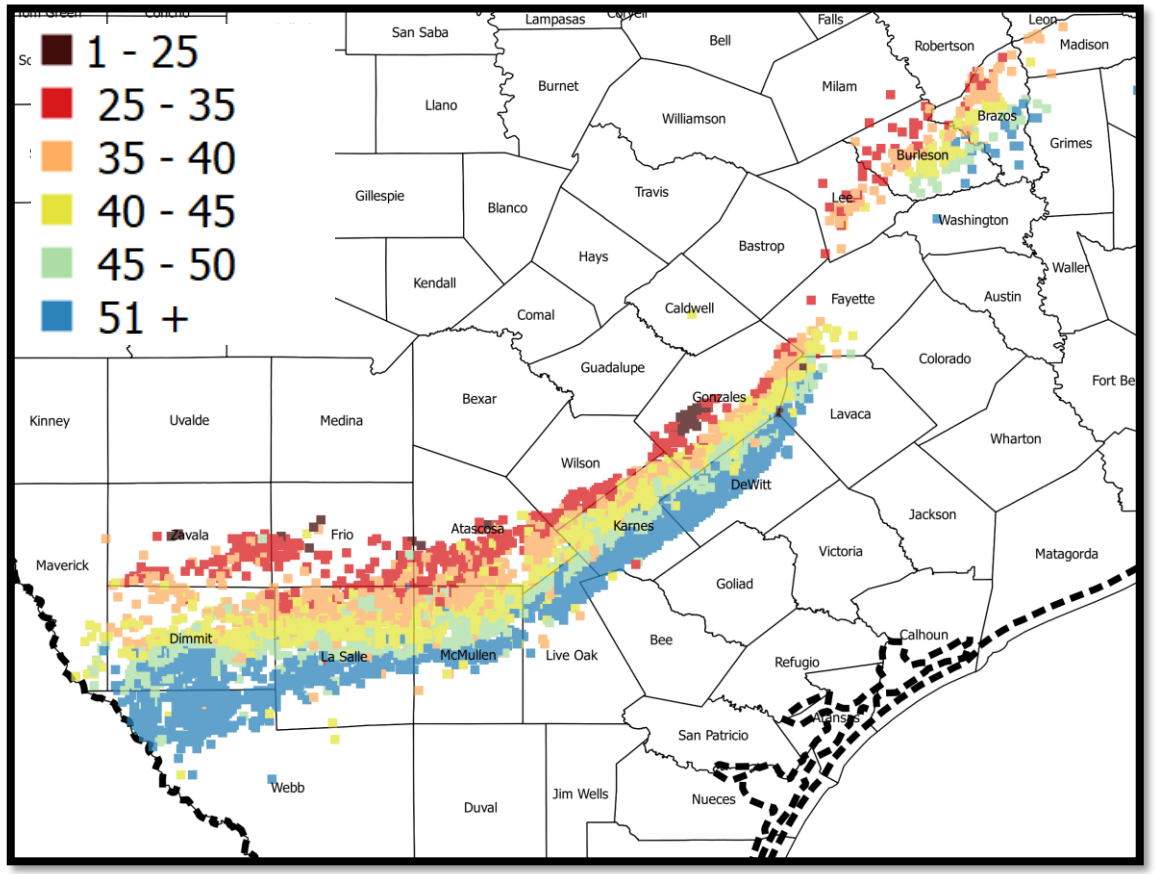


Source: Whiting Q2 Investor Presentation

The Eagle Ford

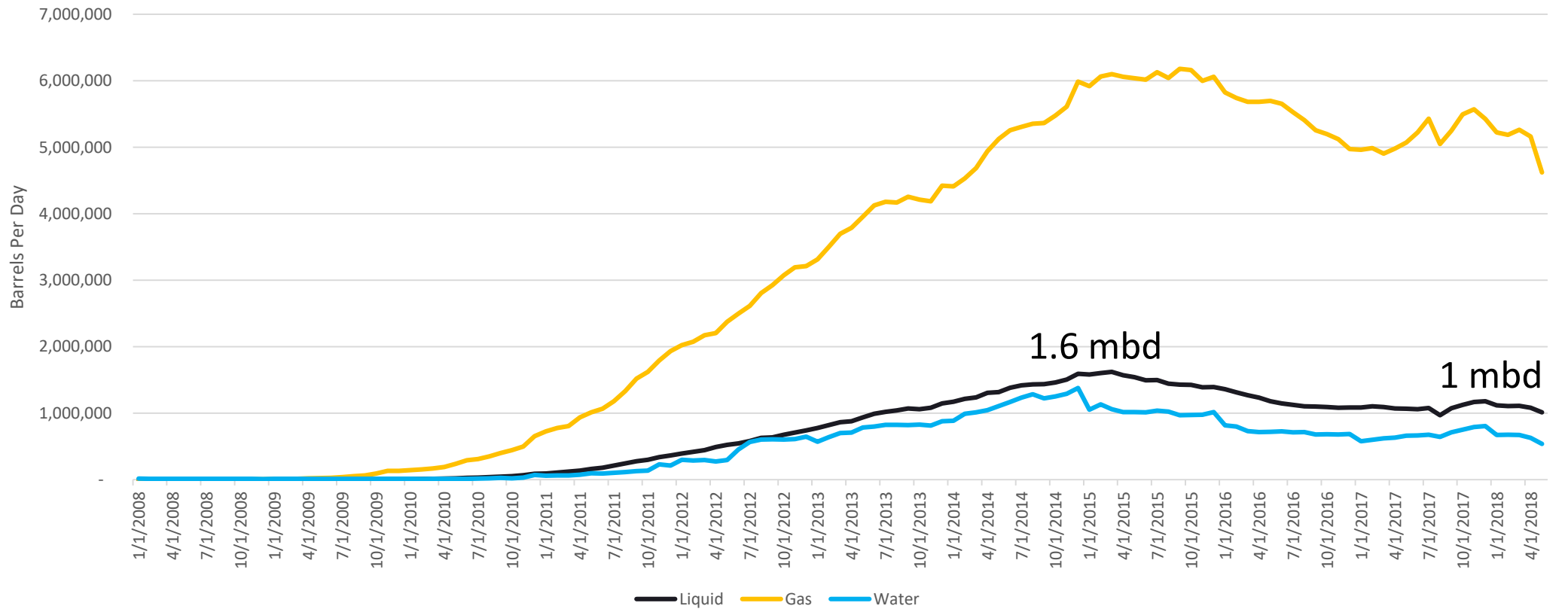
EAGLE FORD RESERVOIR

Eagle Ford API Gravity



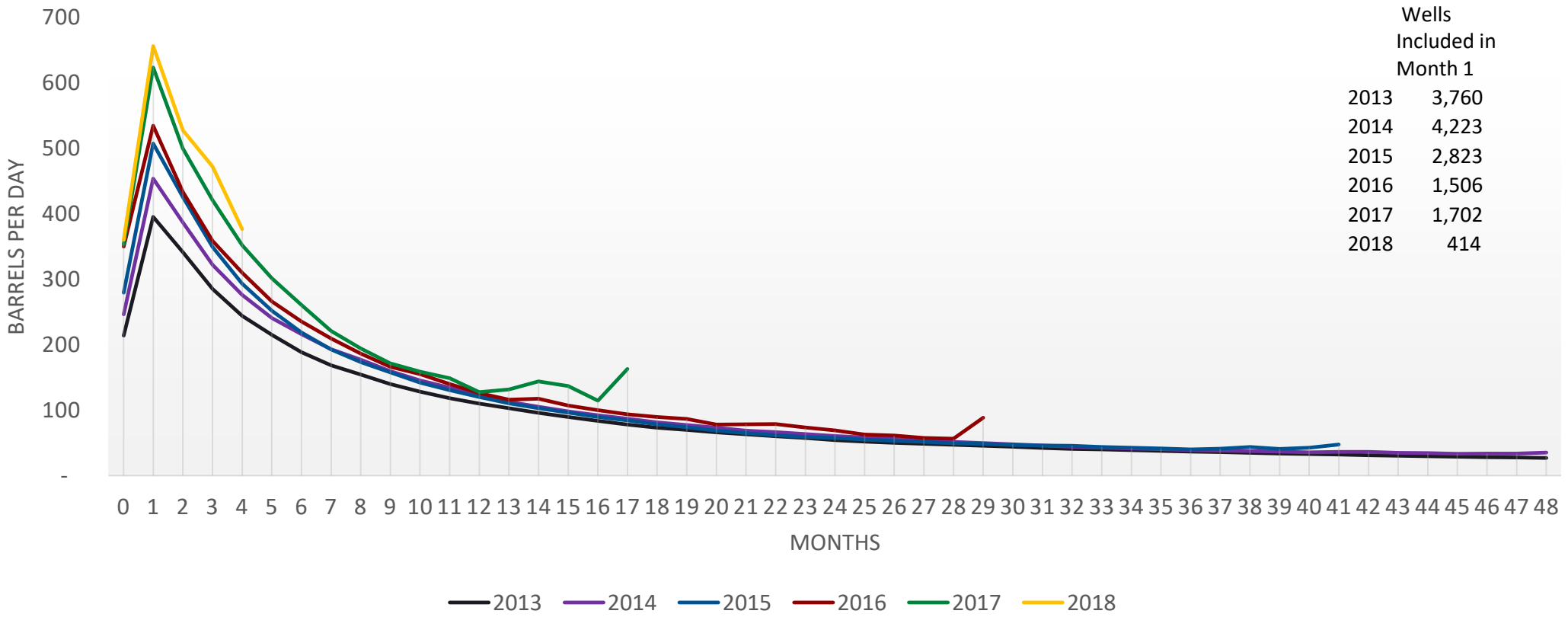
Source: PetroNerds, DrillingInfo

Eagle Ford Reservoir Production



Source: PetroNerds, DrillingInfo

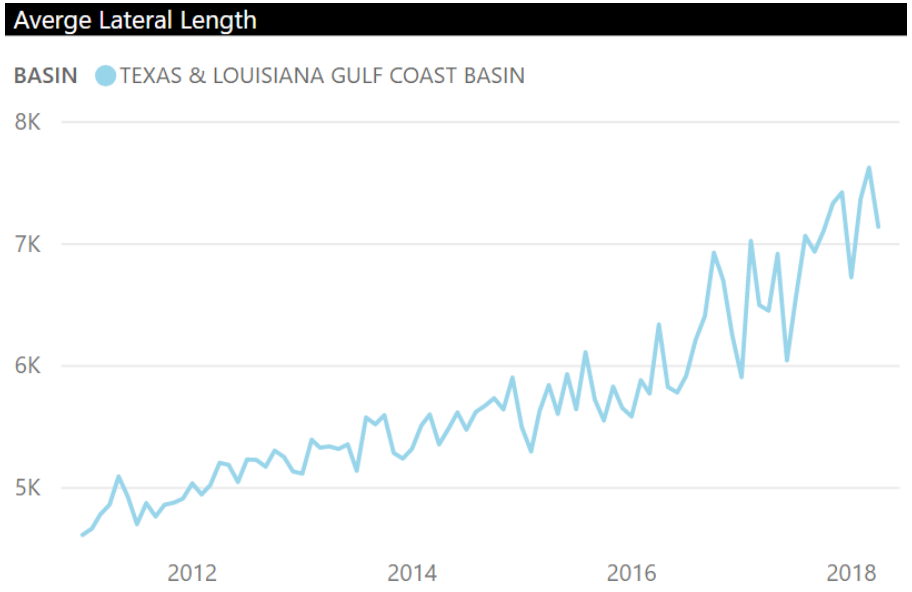
Eagle Ford Horizontal Type Curve

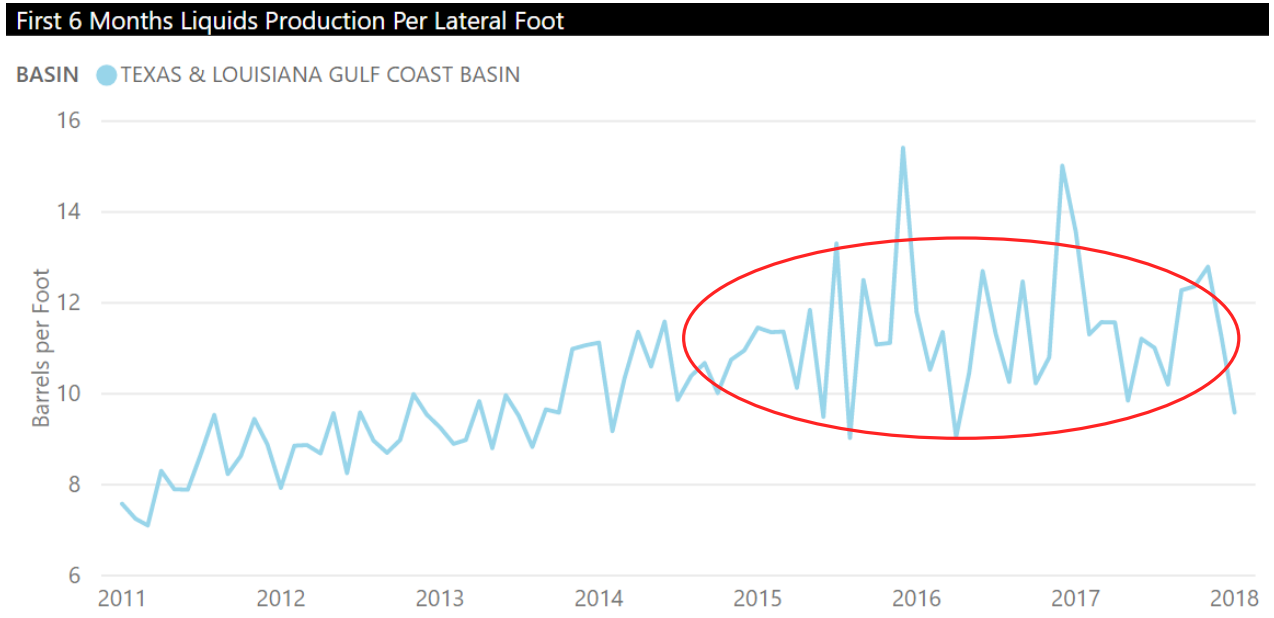


	Wells Included in Month 1
2013	3,760
2014	4,223
2015	2,823
2016	1,506
2017	1,702
2018	414

Source: PetroNerds, DrillingInfo

Eagle Ford Reservoir Productivity

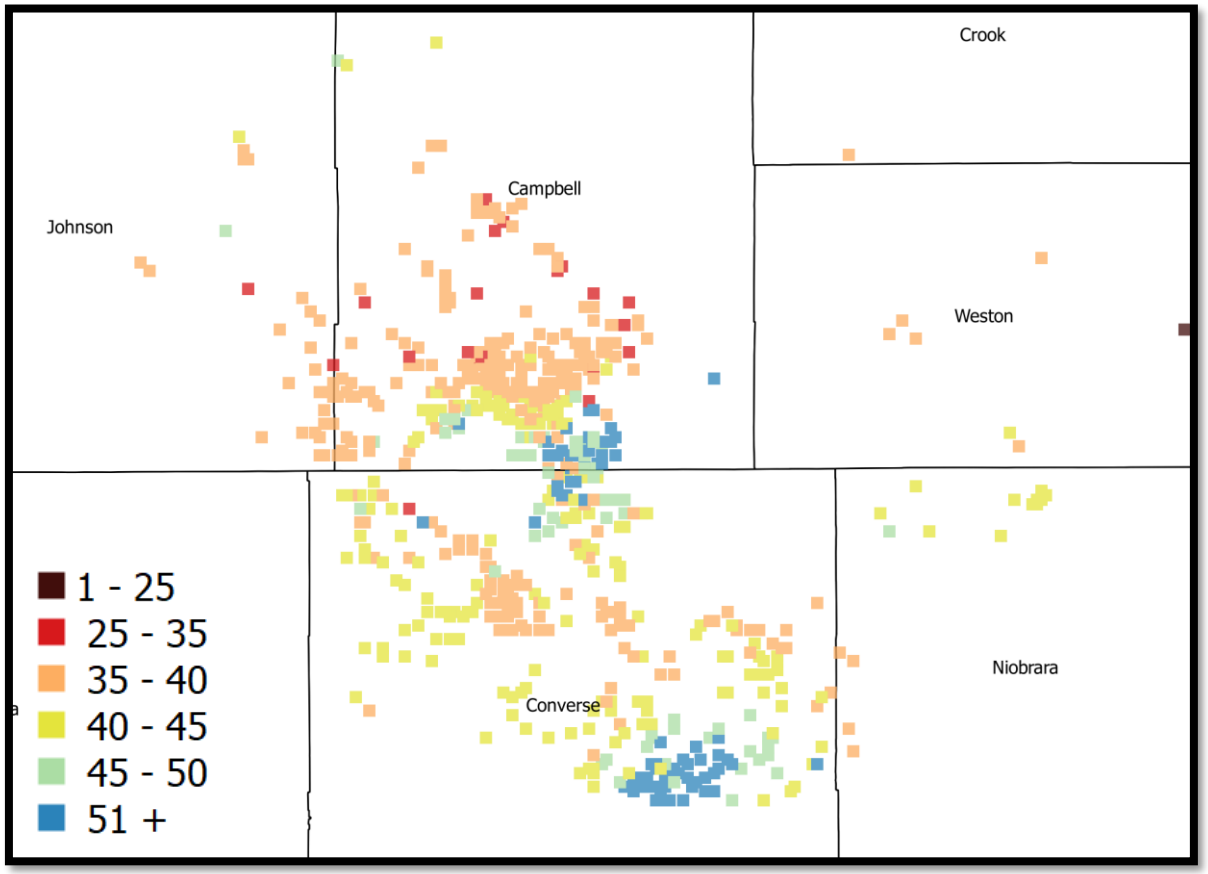




The PRB

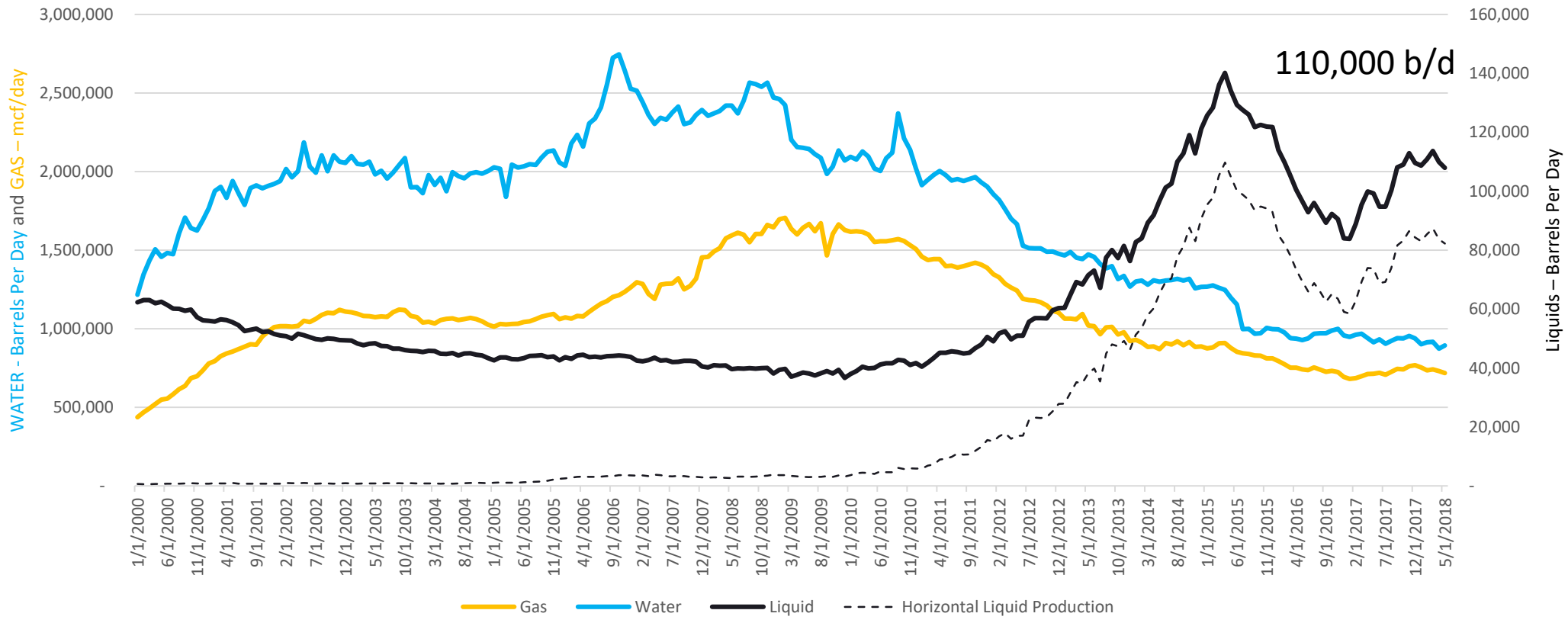
POWDER RIVER BASIN

Powder River Basin API Gravity



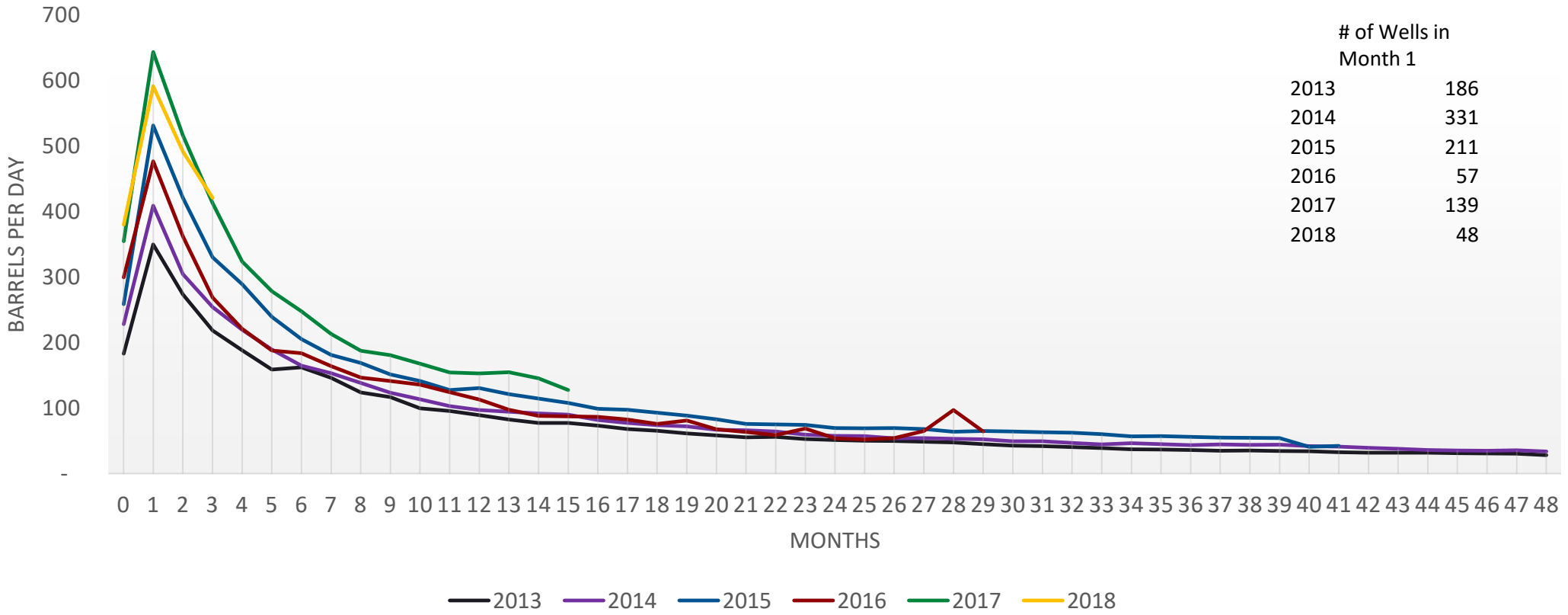
Source: PetroNerds, DrillingInfo.

Powder River Basin Production



Source: PetroNerds, DrillingInfo

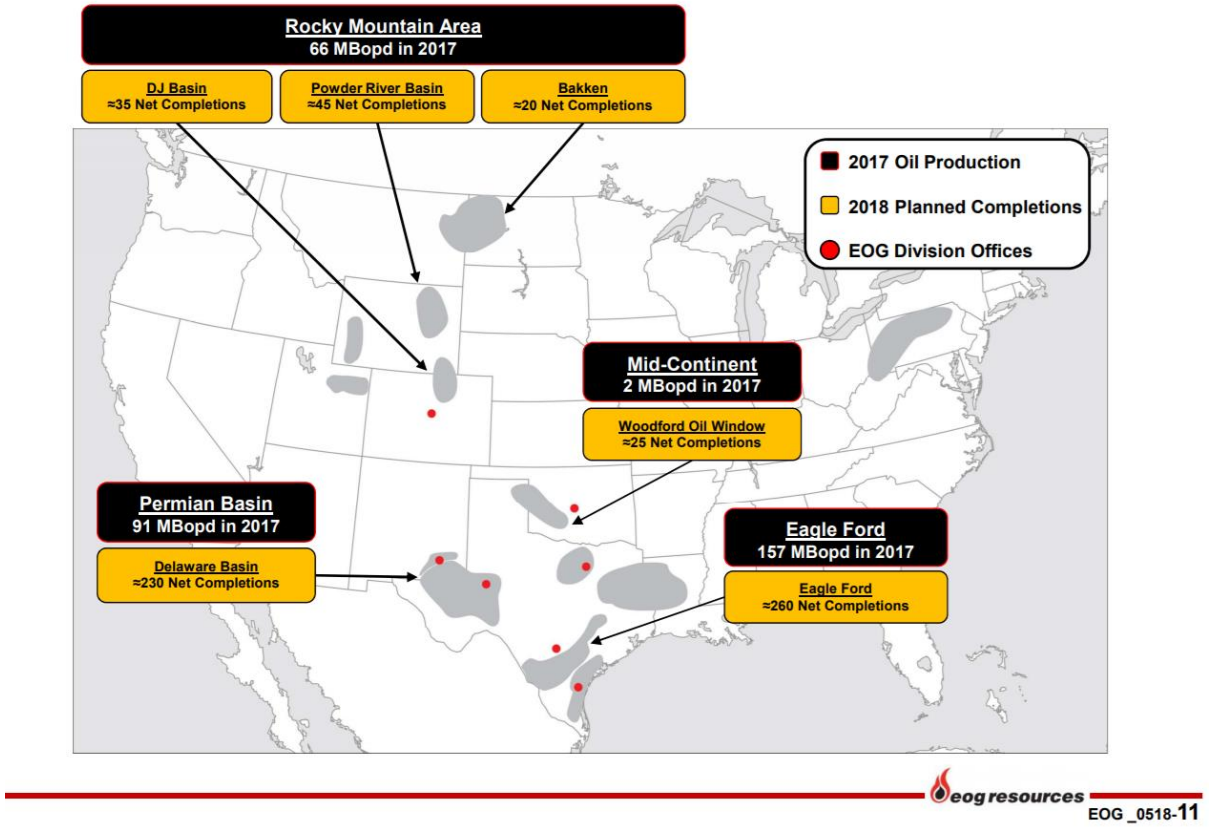
PRB Horizontal Type Curve



Source: PetroNerds, DrillingInfo

Playing Up the Powder

EOG is completing more wells in their prospective Austin Chalk play in 2018 than they are the Bakken. They are completing more than twice as many in the Powder.

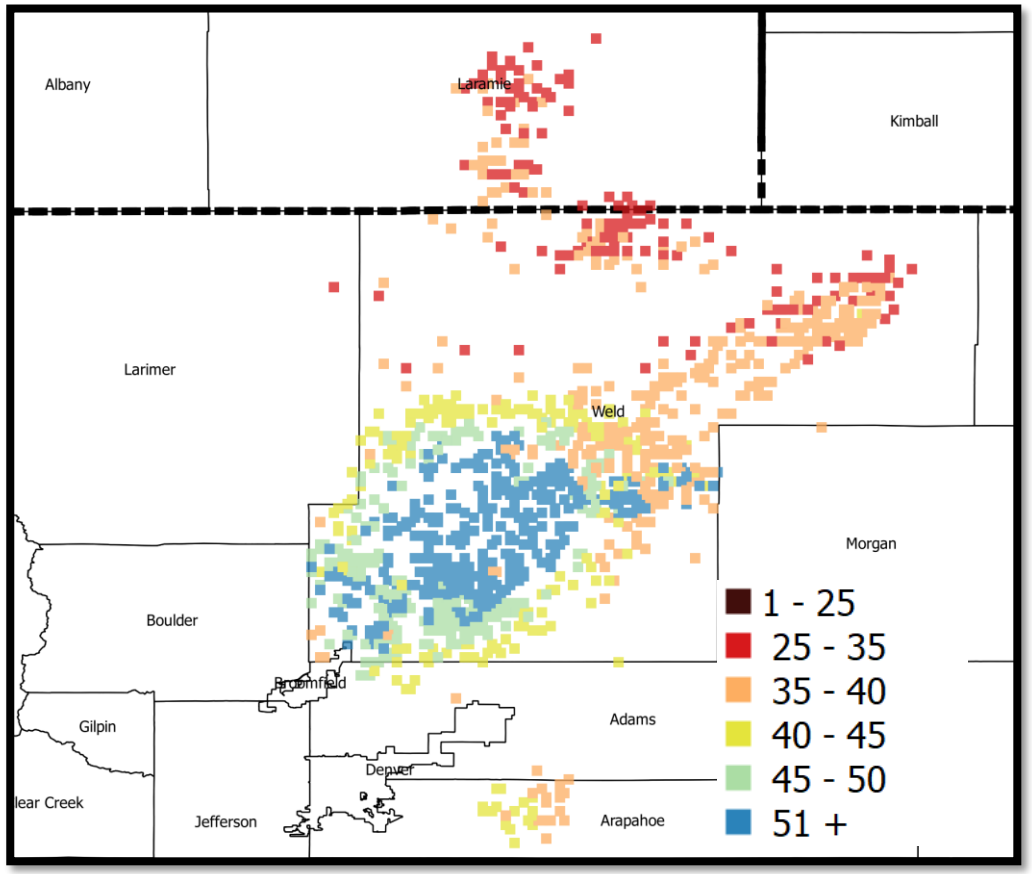


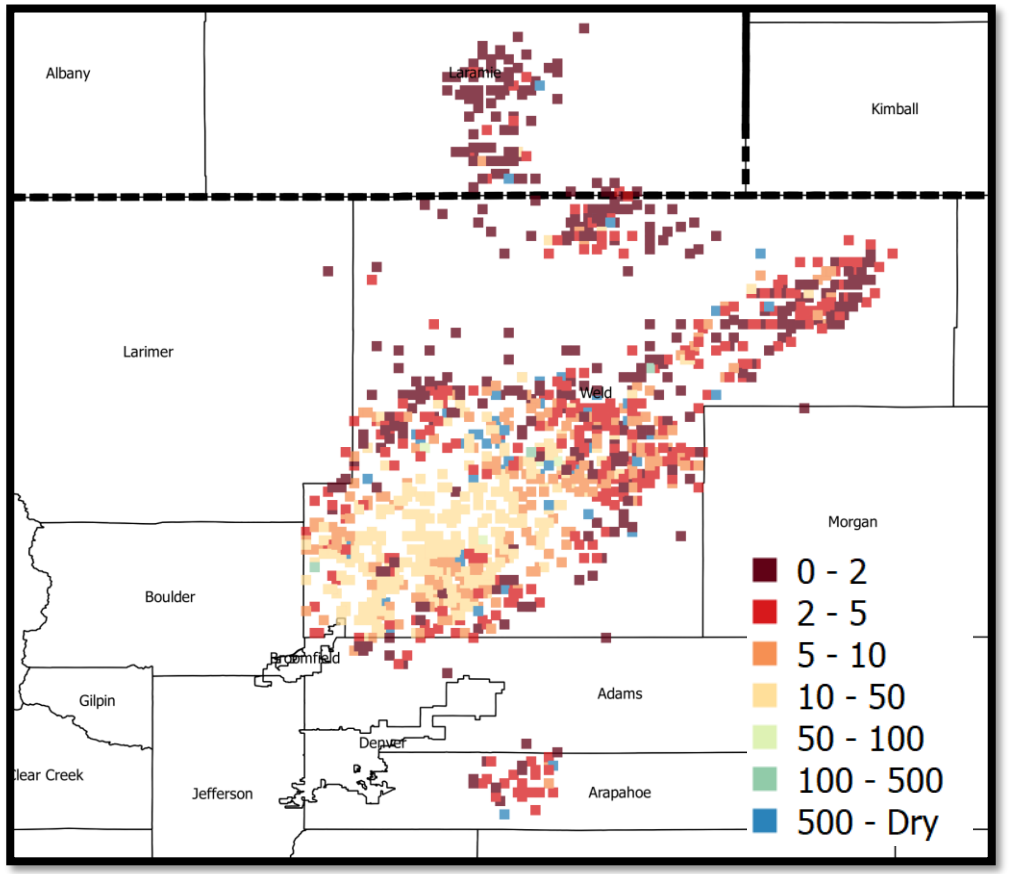
Source: EOG Presentation

The DJ Basin

BRINGING IT HOME – THE DENVER JULESBURG BASIN

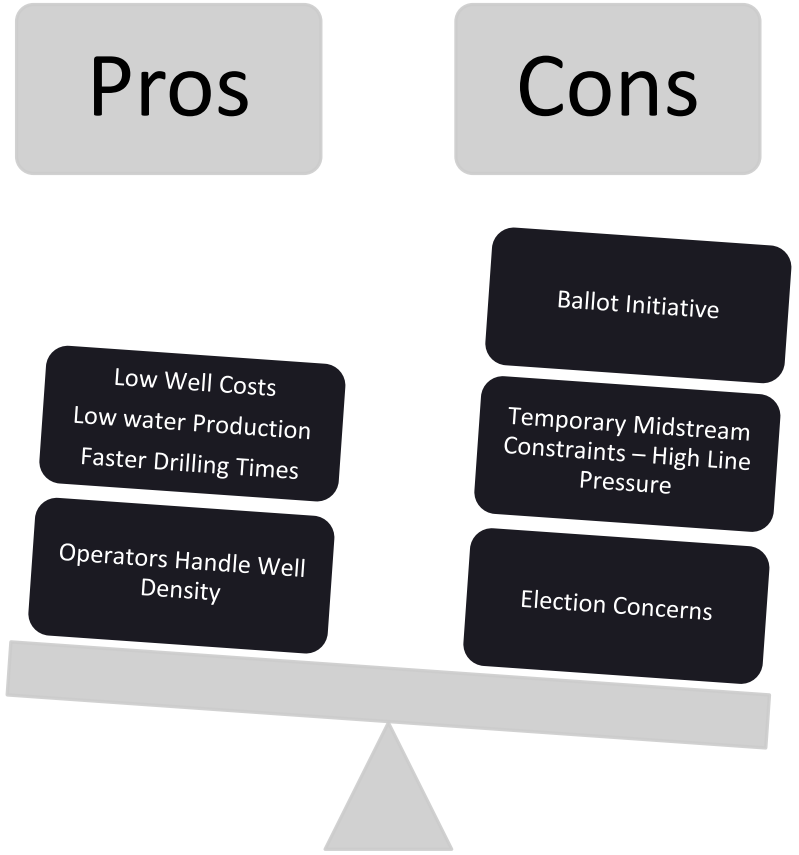
DJ Basin API Gravity and GOR





Source: PetroNerds, DrillingInfo

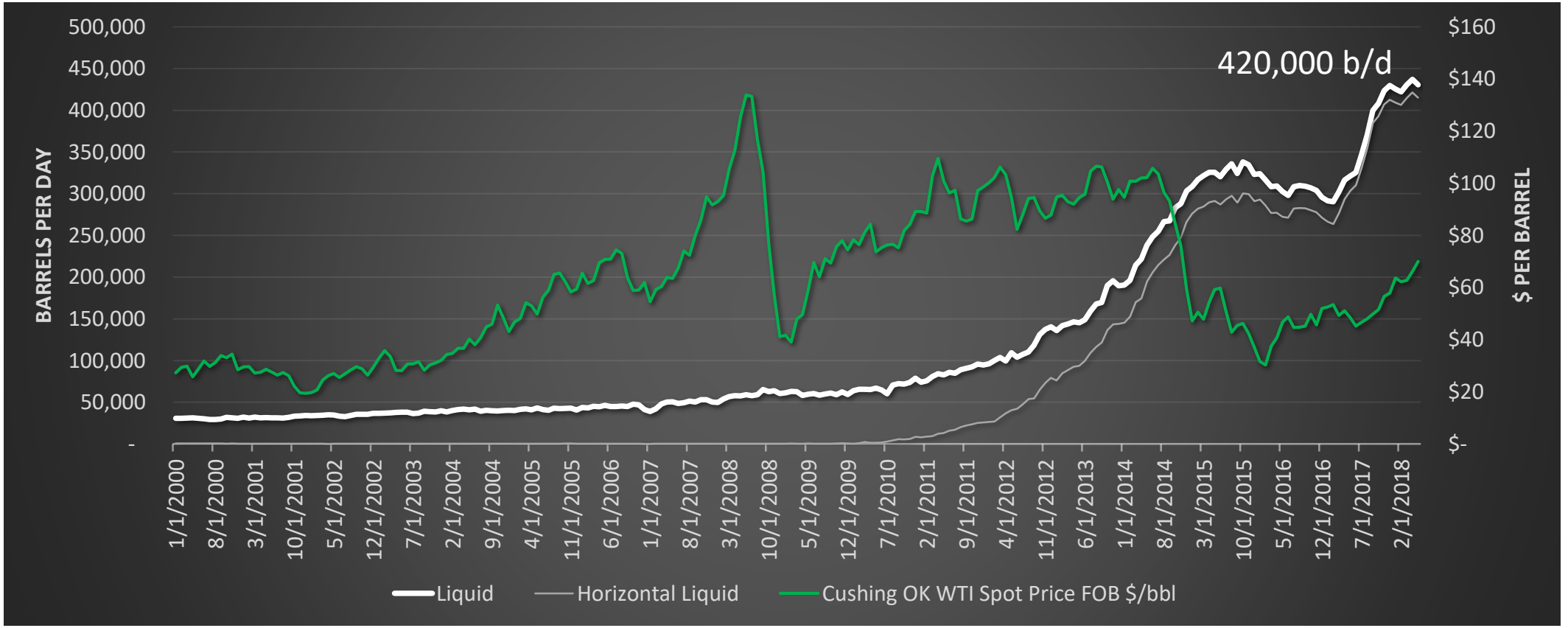
Summarizing the DJ



Dense Well Spacing….Not New in the DJ

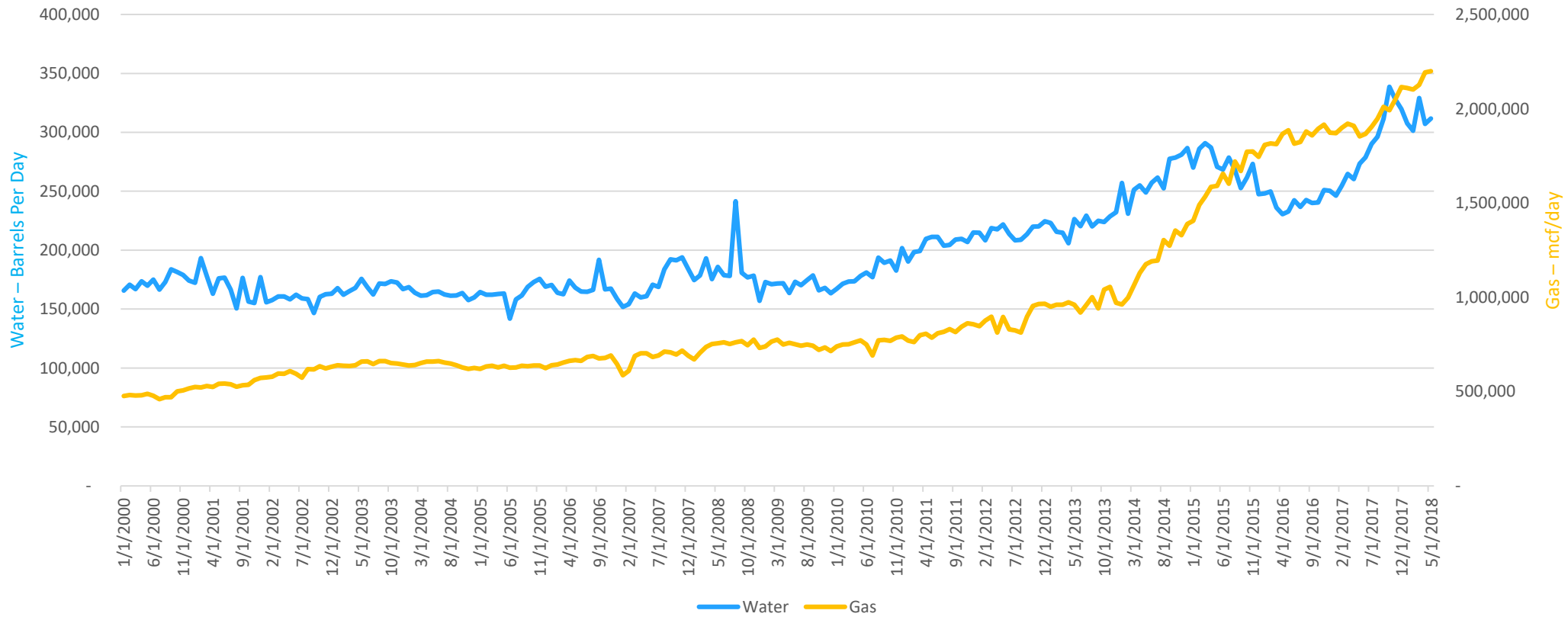
Extraction Oil and Gas, September 2017

DJ Basin Production



Source: PetroNerds, DrillingInfo

DJ Basin Water and Gas Production

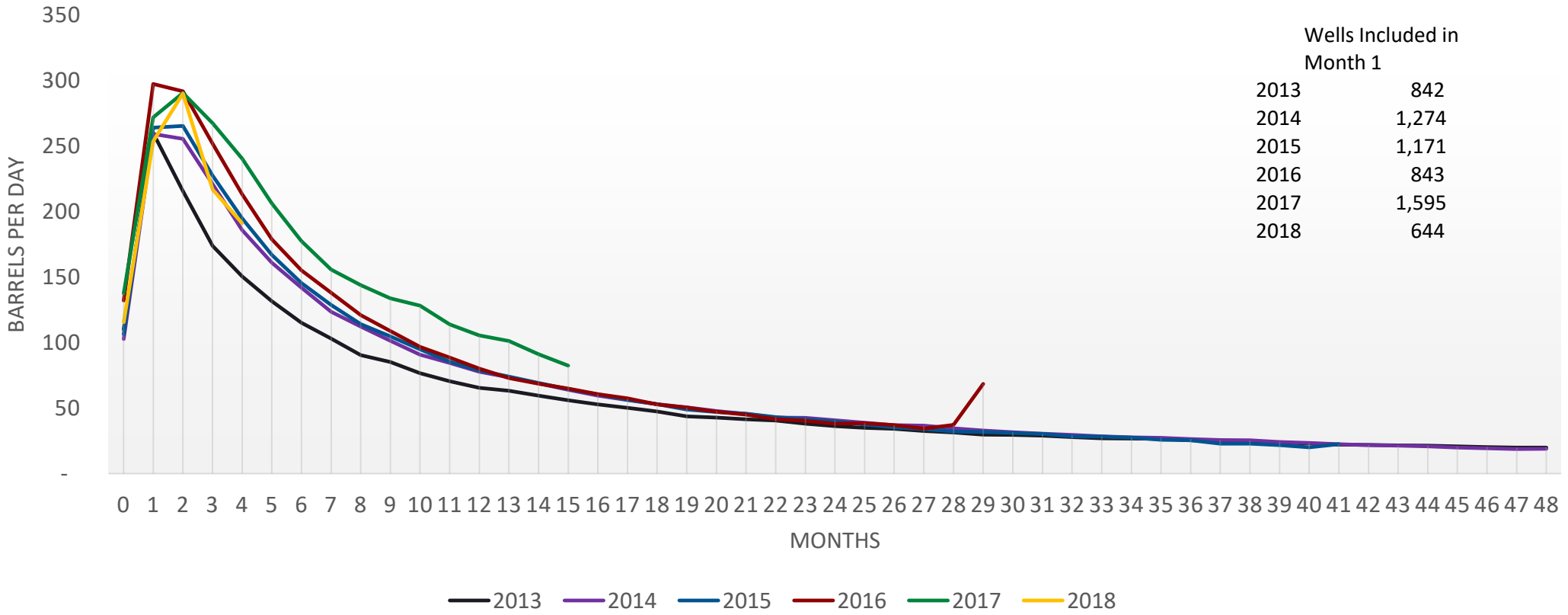


DJ Basin Top Operators by Production

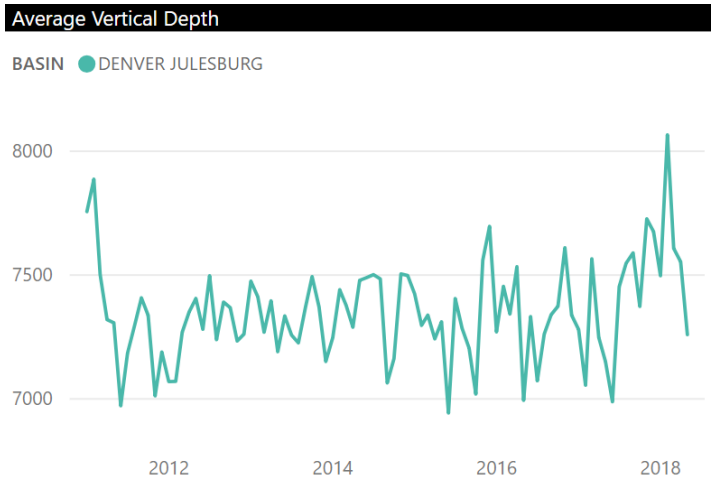
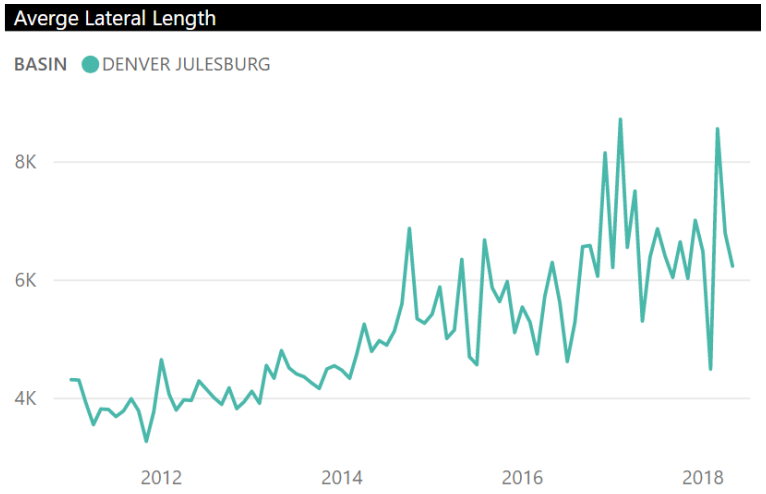
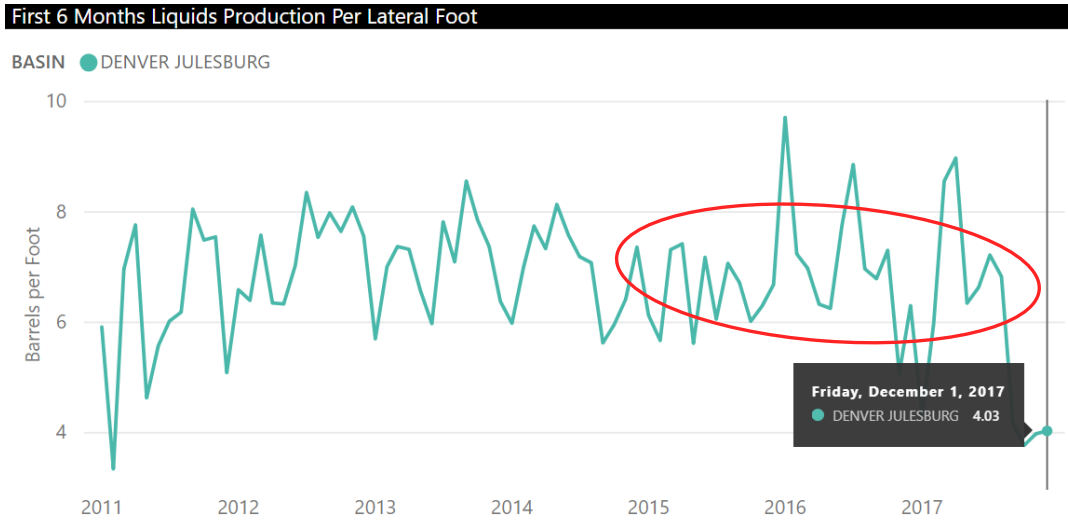
	REPORTED_OPER_NAME	Daily Liquids	Daily Gas
1	KERR MCGEE OIL & GAS ONSHORE LP	102,548	770,978
2	NOBLE ENERGY INC	79,809	354,274
3	EXTRACTION OIL & GAS INC	58,578	219,665
4	PDC ENERGY INC	44,836	307,394
5	SRC ENERGY INC	22,001	143,291
6	HIGHPOINT OPERATING CORPORATION	21,895	70,260
7	WHITING OIL & GAS CORPORATION	18,418	35,916
8	GREAT WESTERN OPERATING COMPANY LLC	17,100	52,414
9	EOG RESOURCES INC	15,961	13,432
10	CRESTONE PEAK RESOURCES OPERATING LLC	14,288	122,560
11	BONANZA CREEK ENERGY OPERATING COMPANY LLC	10,574	39,044
12	CUB CREEK ENERGY	5,295	17,412
13	KAISER FRANCIS OIL CO	4,182	4,731
14	BURLINGTON RESOURCES OIL & GAS LP	2,698	7,261
15	SAMSON EXPLORATION LLC	2,342	2,465
16	FIFTH CREEK ENERGY OPERATING COMPANY LLC	2,154	2,490
17	BAYSWATER EXPLORATION & PRODUCTION LLC	2,149	4,768
18	CONOCO PHILLIPS COMPANY	1,418	3,404
19	CONFLUENCE DJ LLC	892	2,259
20	MALLARD EXPLORATION LLC	836	500

Source: PetroNerds, DrillingInfo

DJ Horizontal Type Curve



Wells Included in Month 1	
2013	842
2014	1,274
2015	1,171
2016	843
2017	1,595
2018	644

Source: PetroNerds, DrillingInfo

DJ Basin Productivity