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The Permian Oilfield Water Wave: Challenges and Opportunities

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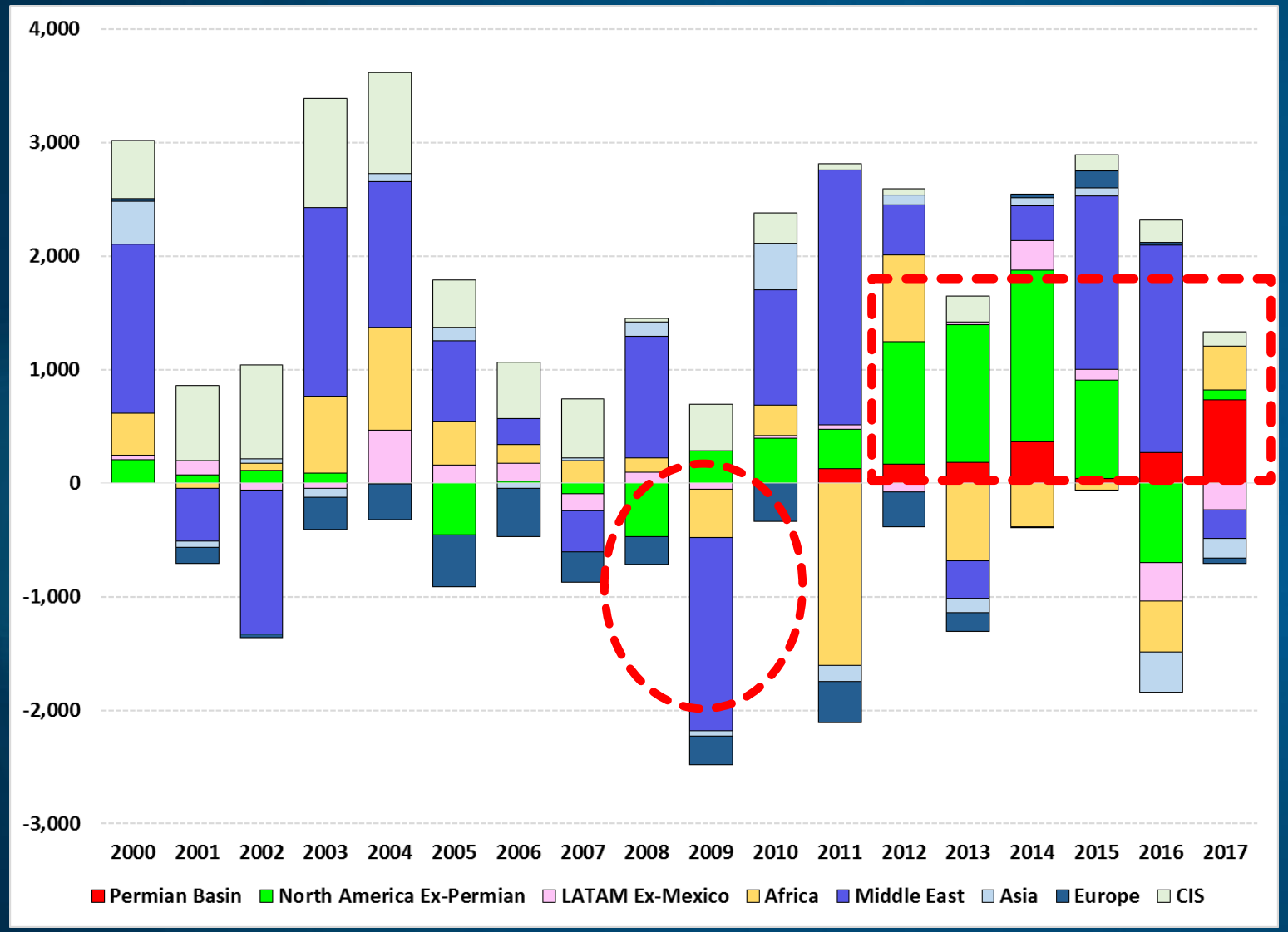
Why Does the Permian Water Issue Matter?

The Permian Basin is Now the World's Premier Non-OPEC, Non-Middle East Source of Oil Supply Growth



Source: BP Statistical Review of World Energy 2018, EIA

North America—led by the Permian Basin (Red)—and the Middle East (Purple) have been the prime drivers of global incremental oil supply growth since 2010.

Maintaining the Permian's position as a key driver of global incremental oil supply growth will require that the water challenge be brought to heel in a cost-effective manner—especially if we want to see a "Permian 5 million barrels of oil per day world."

Per Well

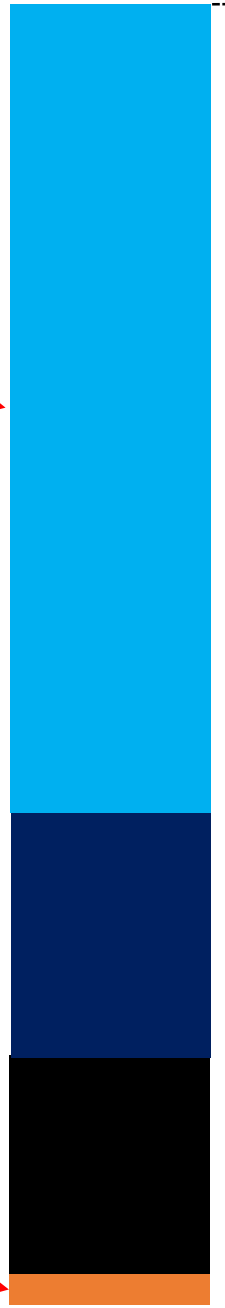
Long-Lateral Permian Oil Well Inputs and Outputs Weigh ~405,000 metric tons

Produced water:
Over 250,000 metric tons

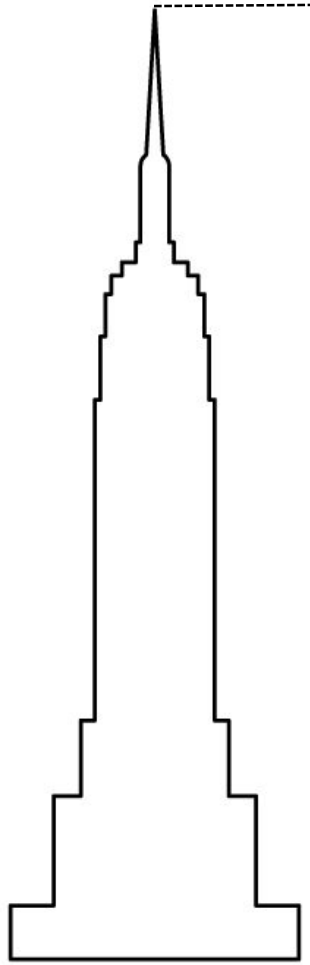
Frac source water:
76,000 metric tons

Crude oil and liquids:
68,000 metric tons

Pipe, sand, misc. consumables:
Approx. 10,000 metric tons



Empire State Building Weighs ~340,000 metric tons



~450 wells drilled per month

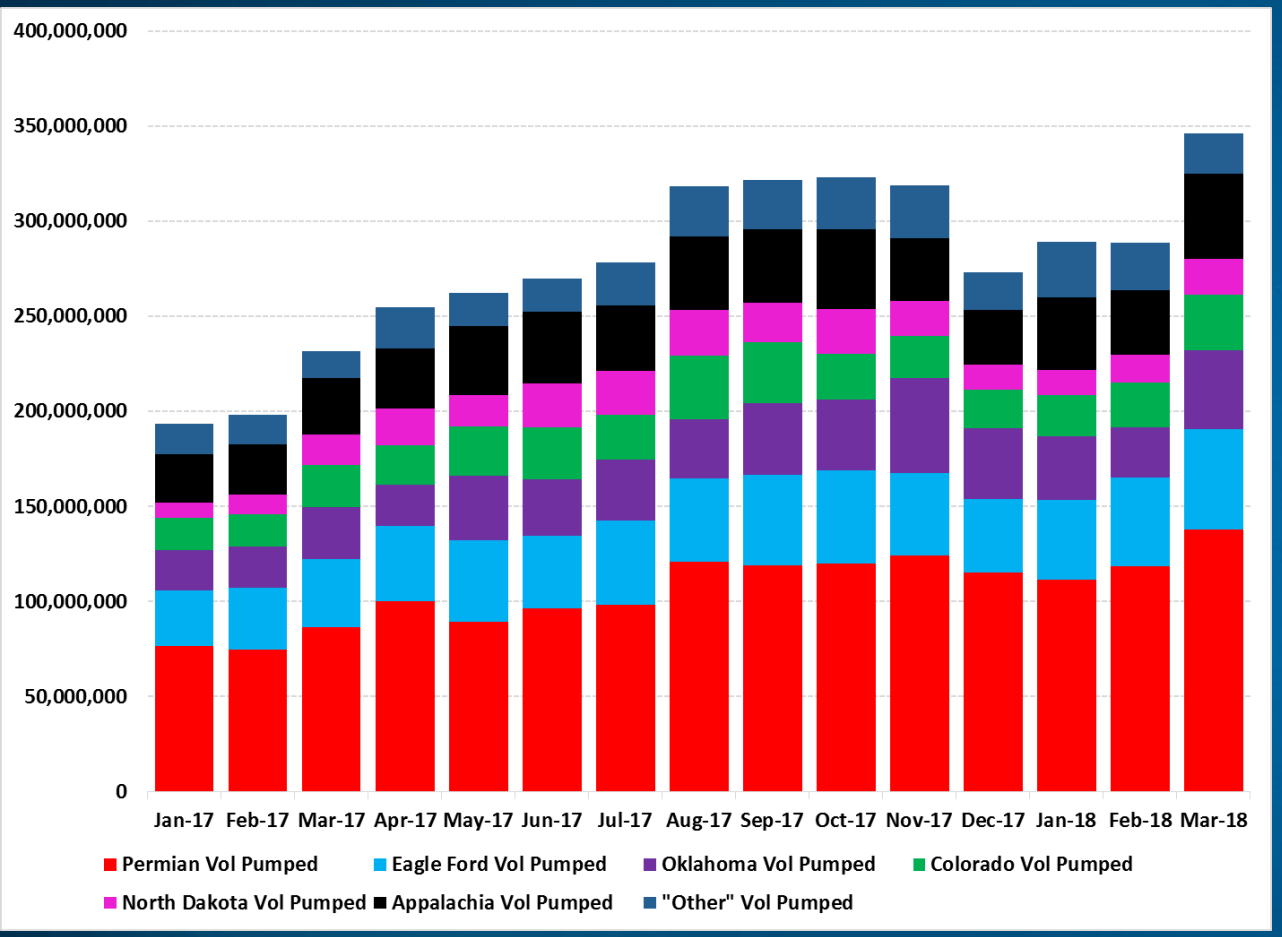
Water will likely account for approximately 80% of lifetime "mass moved" for many Permian Basin wells.

Source: CME Group, Empire State Realty Trust, FracFocus, TexasBrine.com

This analysis assumes 500,000 barrels of oil produced, with a water-to-oil ratio of 3:1. In many cases, wells will ultimately produce more oil and at a higher water cut.

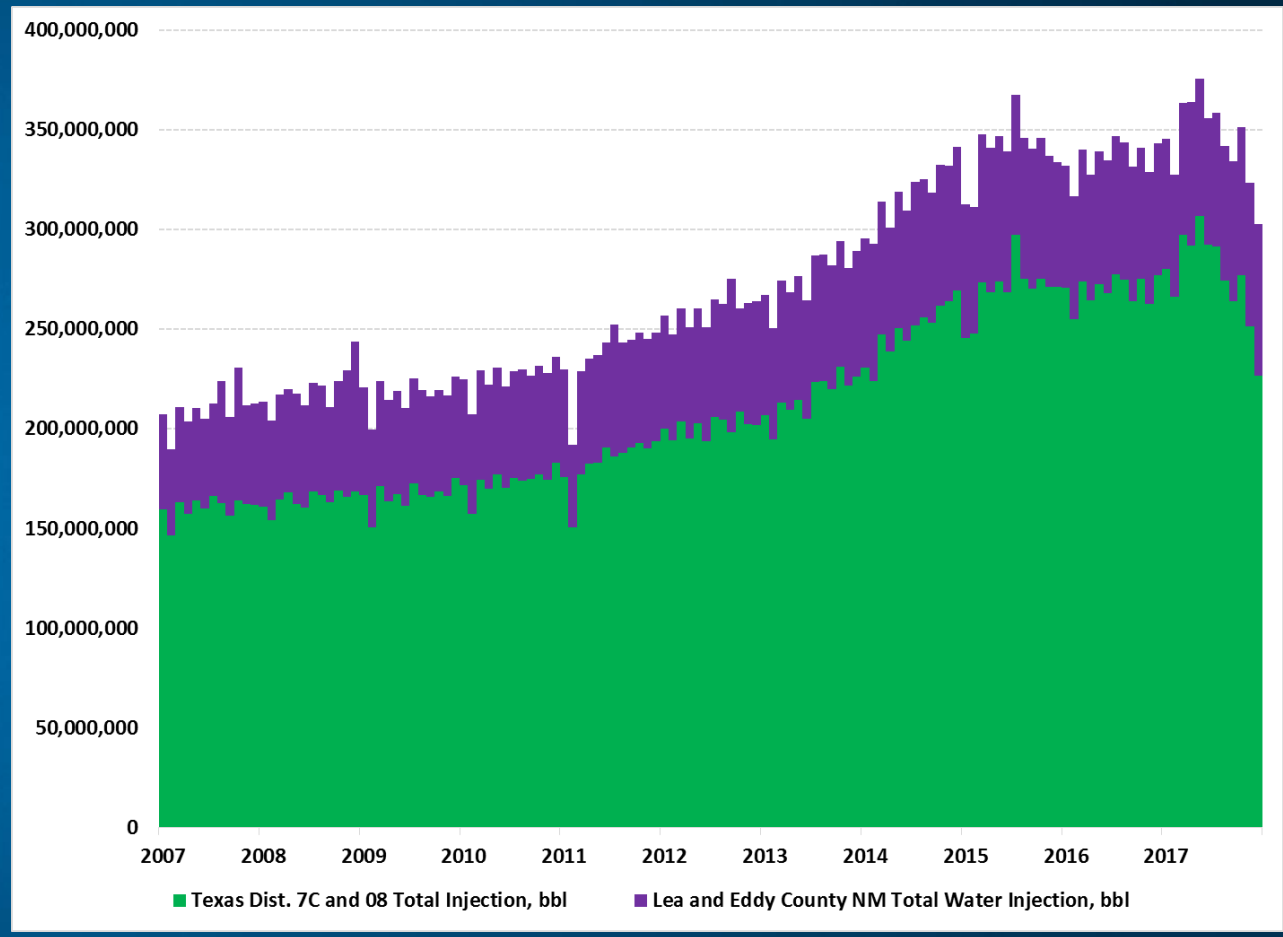
Permian Basin Oilfield Water: Supply & Demand

Frac Water Volumes Pumped (Permian in red)



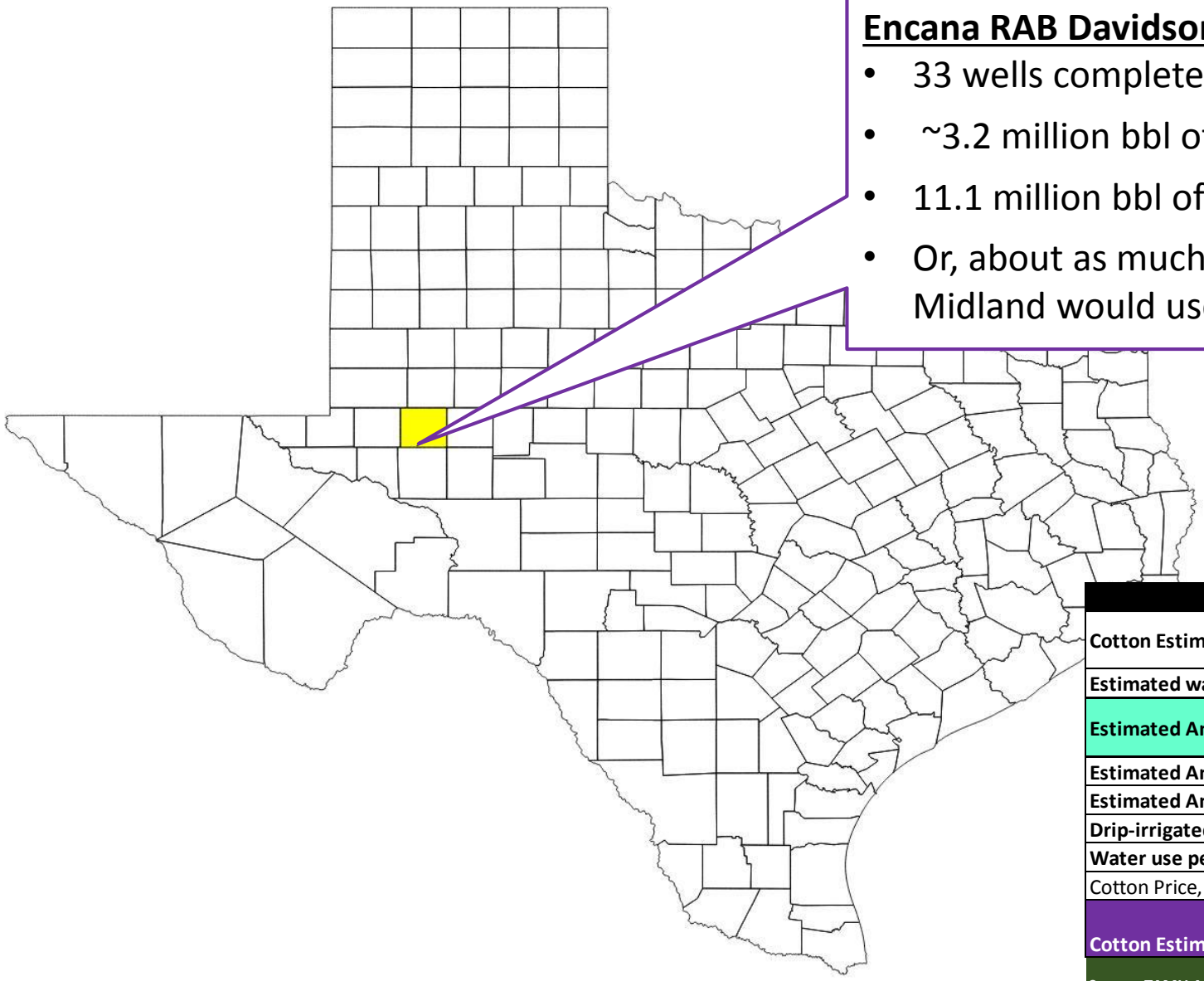
Source: FracFocus

Water Injection—West Texas and SE New Mexico



Source: EIA, NM OCD, Texas RRC

Putting Oilfield Water Flows in Perspective: Fracs & Farms



Encana RAB Davidson Pad:

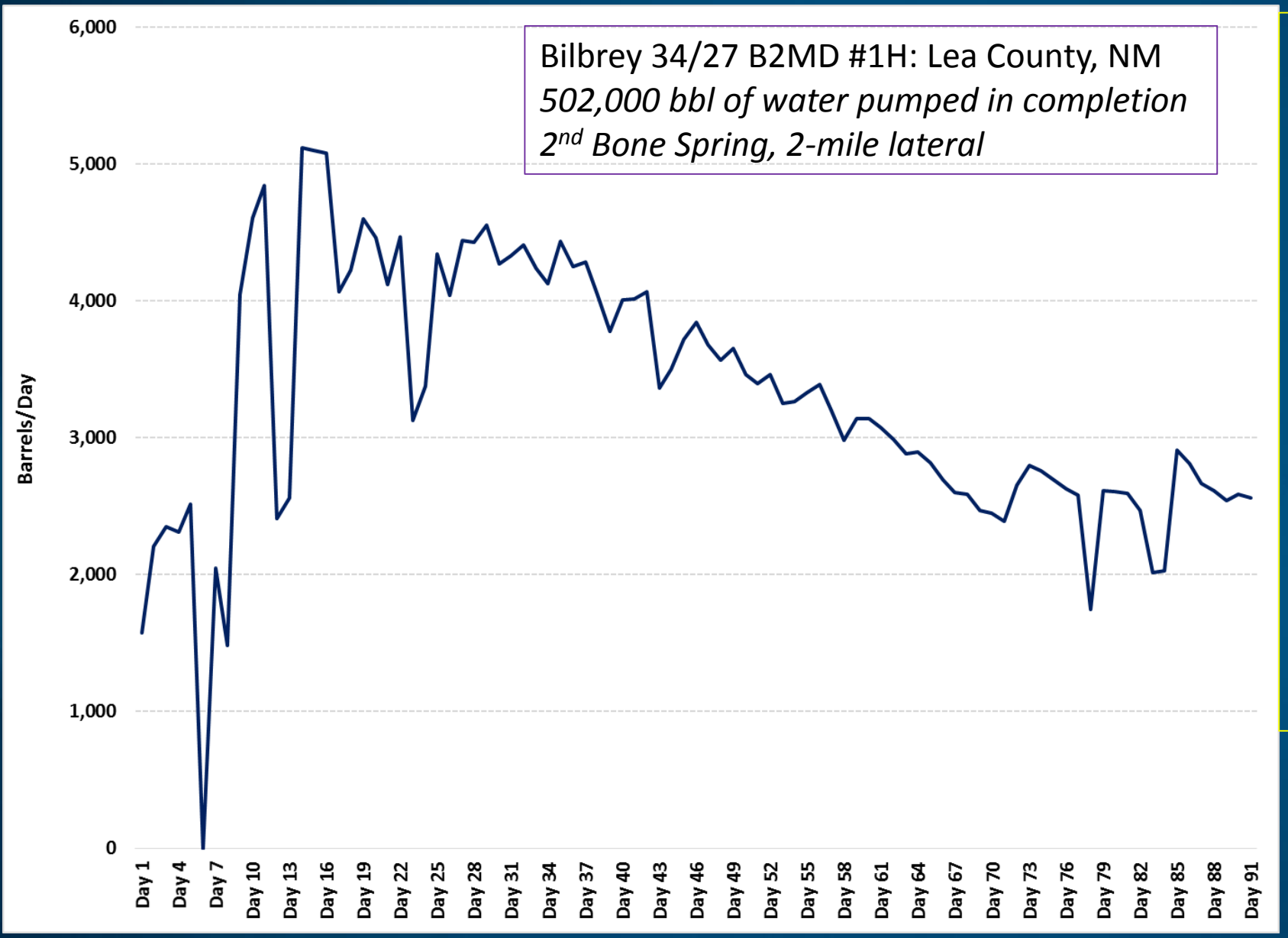
- 33 wells completed between April 2016 and April 2017
- ~3.2 million bbl of oil and 13.3 bcf of gas produced thru Jul-18
- 11.1 million bbl of water pumped
- Or, about as much water as 1,000 acres of cotton grown near Midland would use in a single season

Source: FracFocus, TX DOT, TX RRC

Cotton Estimated Irrigation Need (District 2)	**18**	**ac-in**
Estimated water system efficiency	**95%**	
Estimated Annual Water Needs of 1,000 acres of cotton, AF	**1,579**	
Estimated Annual Water Needs of 1,000 acres of cotton, barrels	**12,249,474**	
Estimated Annual Water Needs of 1,000 acres of cotton, gal	**514,501,579**	
Drip-irrigated cotton lint yield per acre, annual	**1,500**	**lbs**
Water use per lb of cotton lint	**326**	**gallons**
Cotton Price, USDA West Texas (2017)	$0.74	per lb
Cotton Estimated Economic Output Per Gallon	**$0.002**	

Source: TAMU Agricultural Extension (District 6 crop budgets), USDA

Putting Oilfield Water Flows in Perspective: Frac Flowback



Perspective:

- This well's cumulative 90 day flowback volume could fill about 19 Olympic-size swimming pools (660k gallon pool size)
- Now scale this out for a pad drill project with 5, 7, or even 12 wells, with many of them flowing back simultaneously post-completion.
- The resulting water management challenges—from both the perspective of managing peak flow and that of just managing the sheer volume—are substantial.

Source: Well Report Data

Myth Busters

- "We are water companies subsidized by the oil revenues."—paraphrase of anecdotes overheard at various conferences over past year or so.
- The response in one word? "NO!"
- Water poses a logistical challenge for energy producers.
- It also creates sizeable economic opportunities.

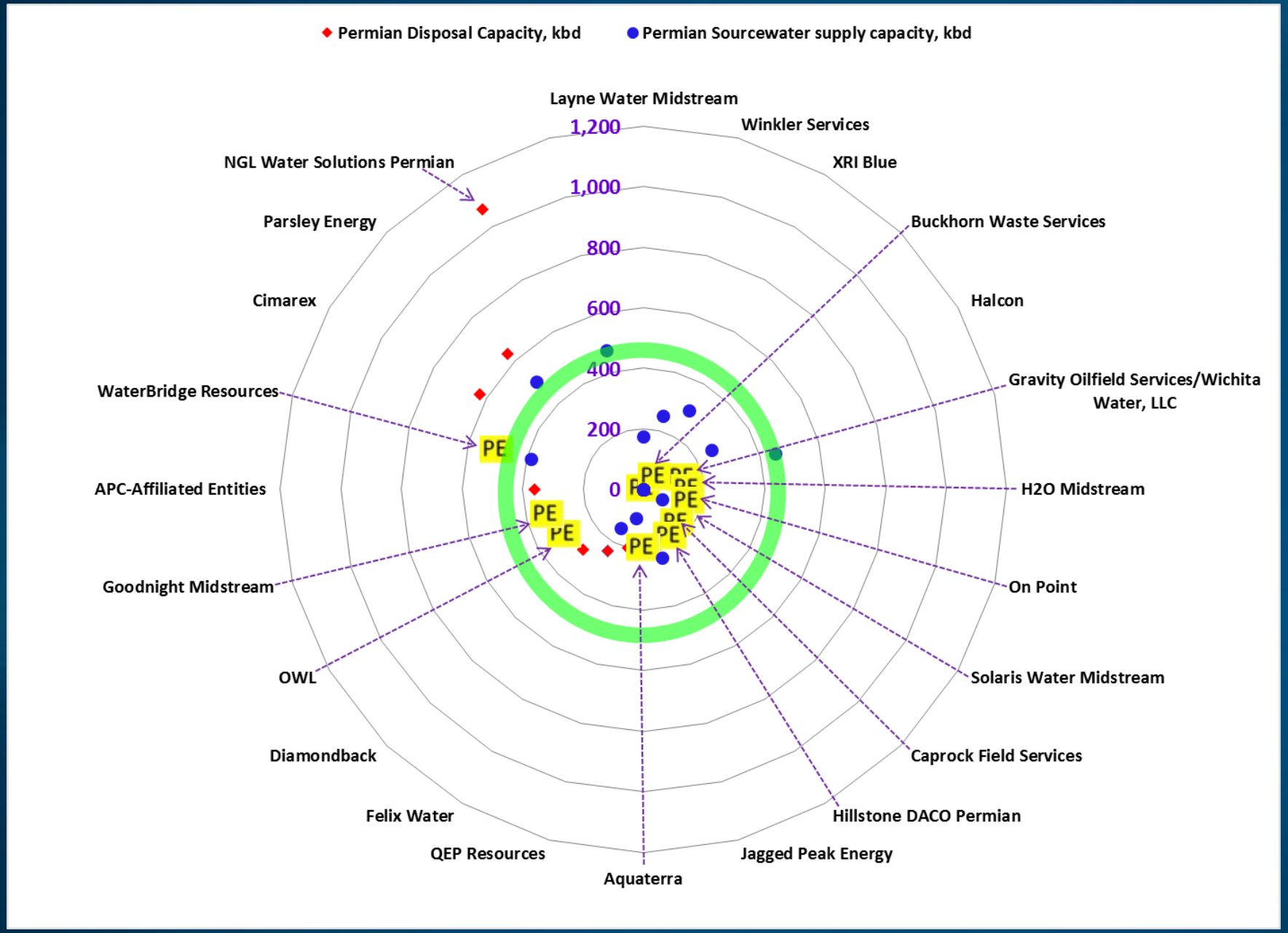
Musonoie-T17 open pit mine in DRC—2.66% copper content by mass in ore. So the miner moves about 97 lbs of rock for every pound of copper recovered

Source: Katanga Mining Limited

Credit: dhayward

Now imagine if miners like this told the investment community that "we are in the rock moving business and are just subsidized by the copper."

Permian Basin Oilfield Water Space Ripe for Consolidation and Organic Growth



"PE" = Private Equity-Backed

If sponsors and management teams were so inclined, the simple math is that combining 2-3 of the yellow highlighted PE-backed entities could create an entity that would have the nameplate capacity to handle enough water to potentially justify a billion dollar enterprise valuation.

Source: Texas RRC, NM OCD, Company Reports, Author's Analysis

Will E&Ps Decide to Run Their Own Water Systems?

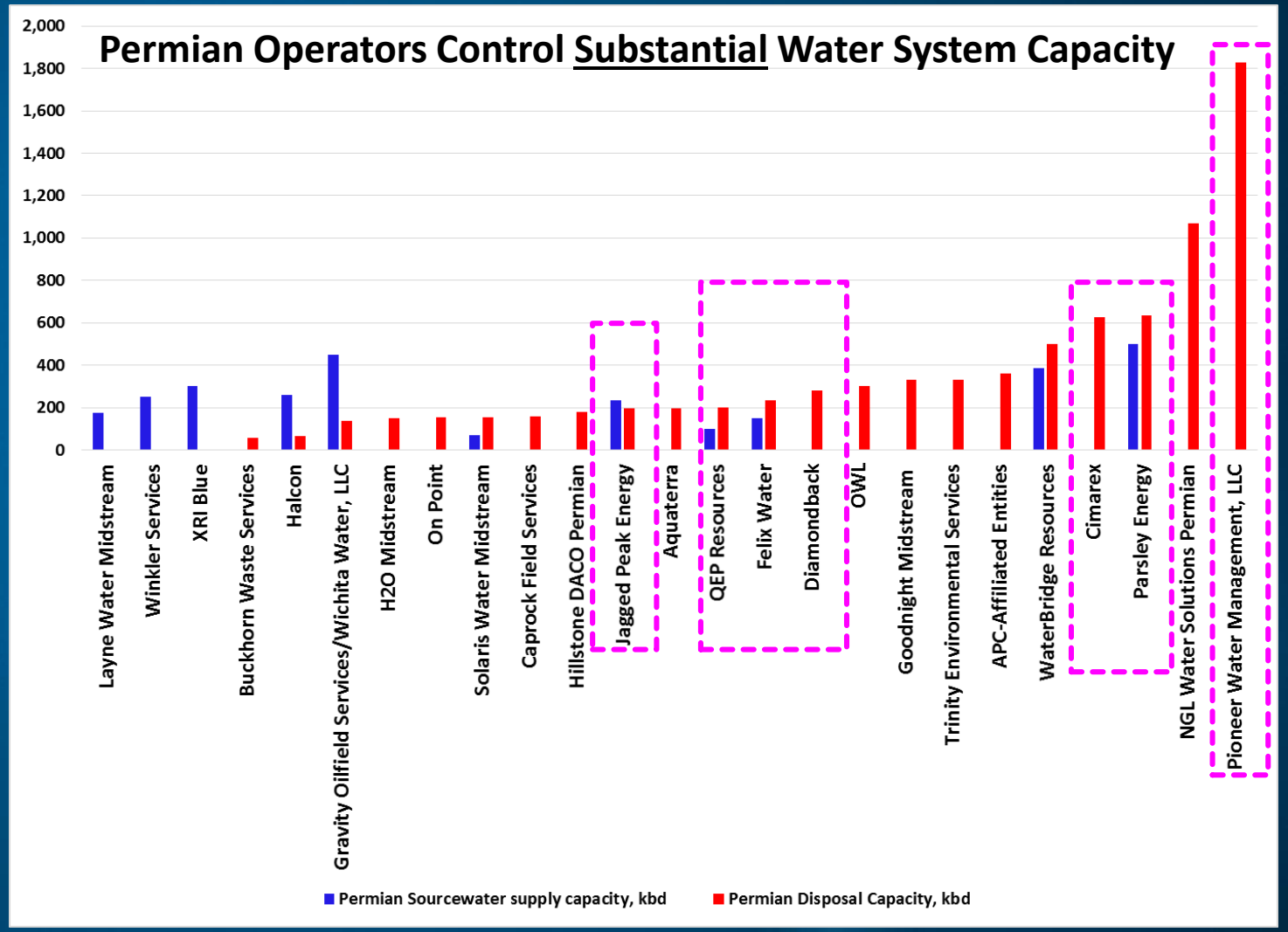
Midstream parties acknowledge the risk…

OMP, 2017 10-K, P.29

"…Potential third-party customers could decide to process and dispose of their produced and flowback water internally or develop their own midstream infrastructure systems for produced water and flowback water gathering and freshwater distribution…"

Source: https://diginomica.com/2014/08/12/rackspace/

But do they <u>really</u> think it will happen?



Source: Texas RRC, NM OCD, Company Reports, Author's Analysis

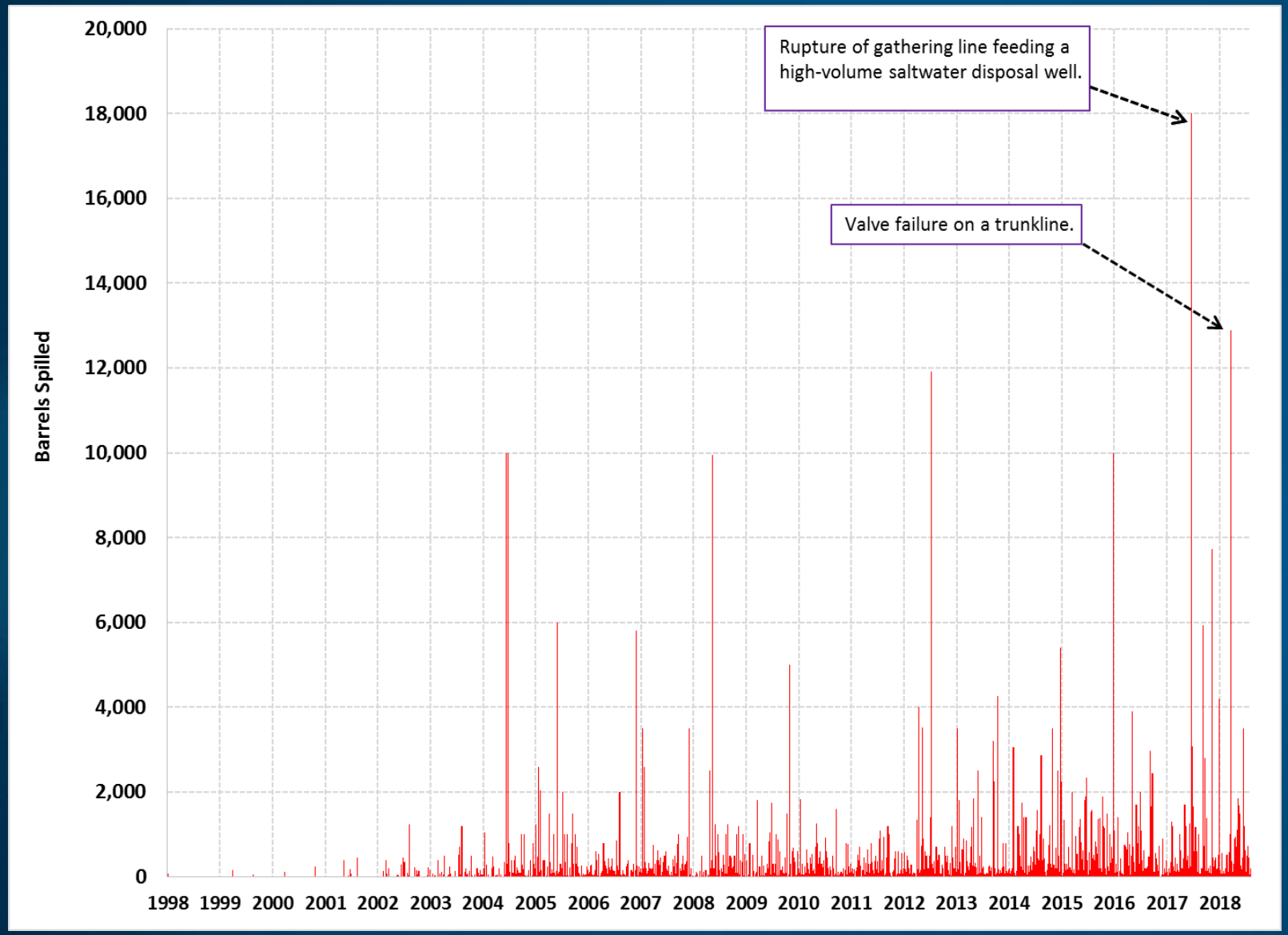
The X-Factors: Political, Regulatory, Operational, and Social License Factors

Road Damage and Dangers

Source: Axios, NPR, YouTube screen captures

Water Release Concerns

New Mexico Permian Produced Water Spills (Barrels)

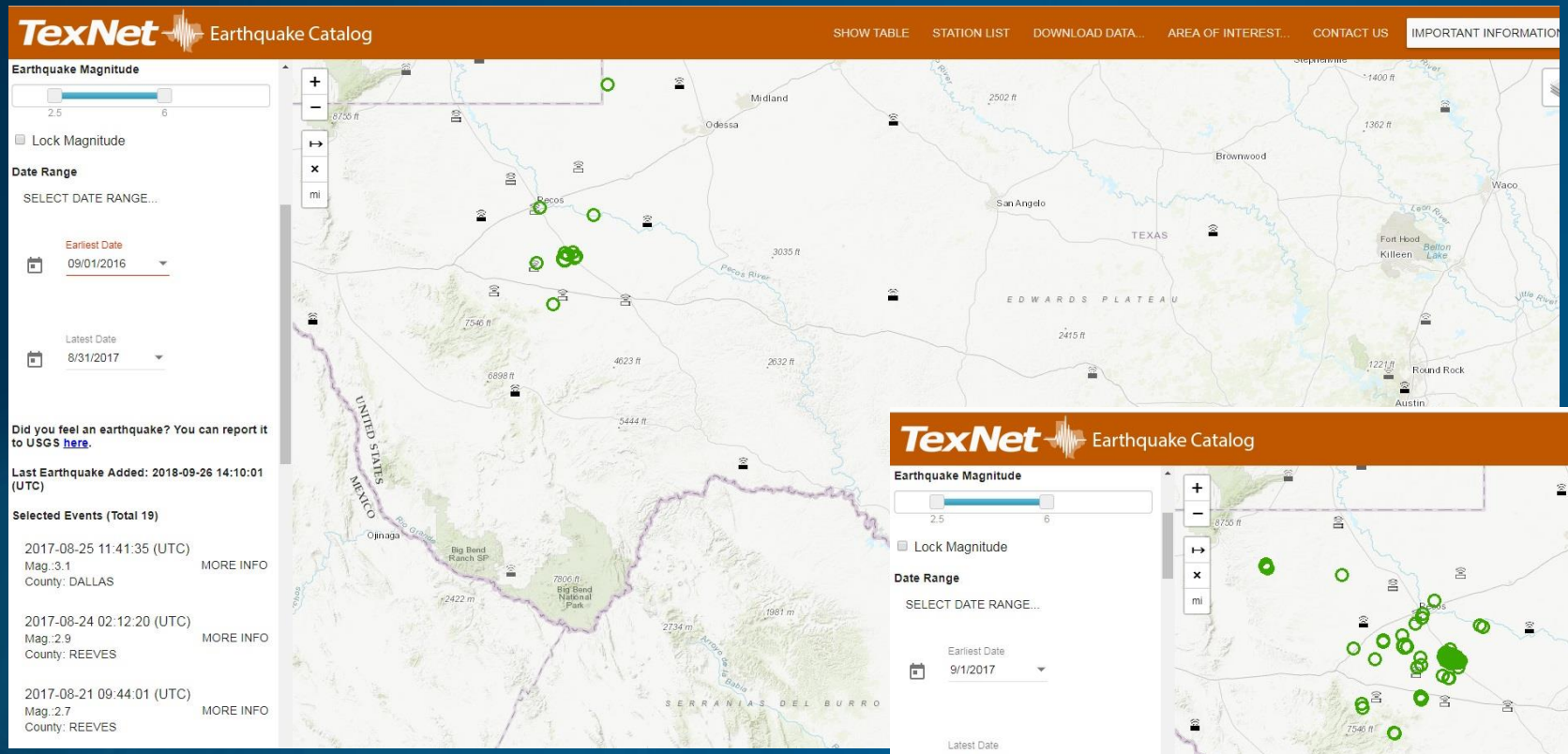


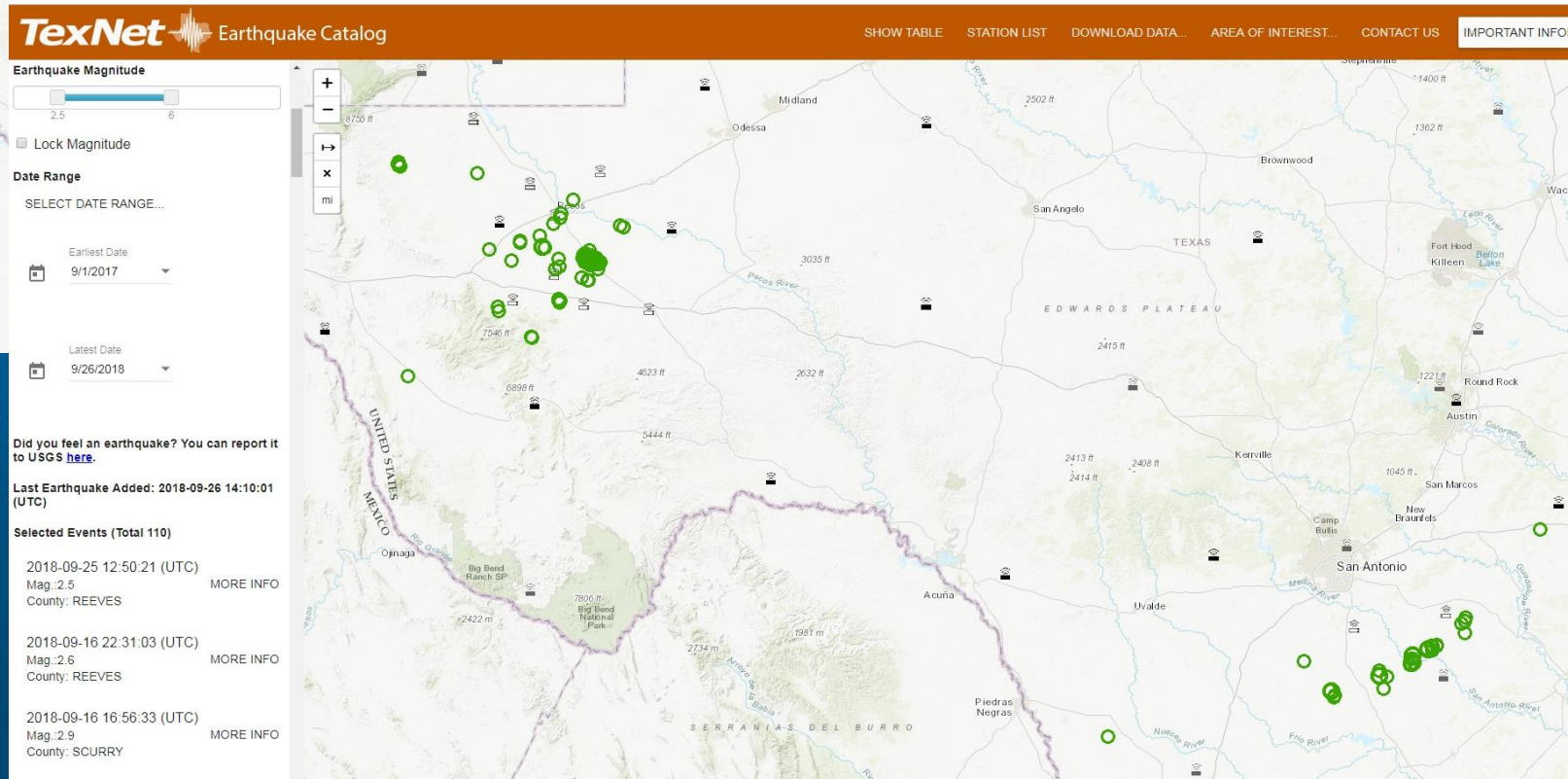
- The Texas RRC should consider systematically tracking produced water spills and making the data publicly available, as New Mexico and North Dakota do.
- Transparency drives better policy and better positions industry to respond proactively to potential challenges, rather than having a reactive solution imposed on it.

Source: NM OCD

How Much “Headroom” Is Left to Expand Injection Disposal of Produced Water?

Seismicity Concerns: Rising Incidence, But Unclear Causality





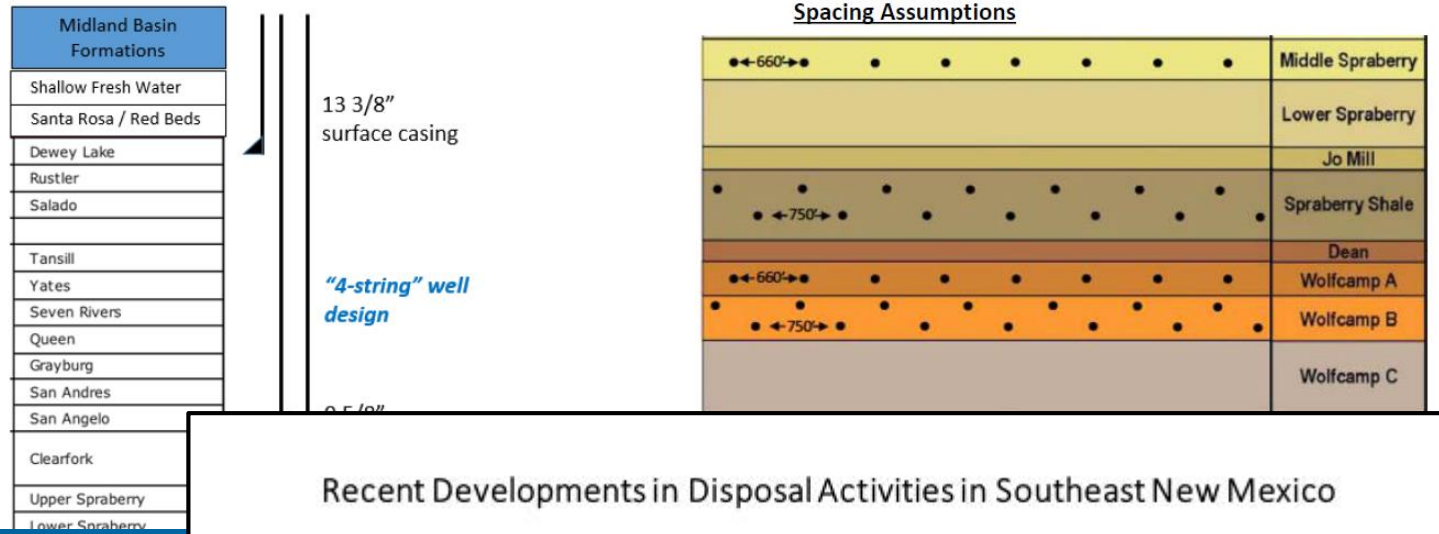
Operational Interference

- **At least two distinct problems:**
  1. **Drilling wells in areas with intermediate zones over-pressured by water injection disposal costs significantly more**
     a) ~$600k per well in Midland Basin due to need for extra drilling liner, according to Guidon Energy
     b) If operators are targeting the Wolfcamp A, Wolfcamp B shale, and Wolfcamp B carbonate layers, this could translate to costs of about $13 million for every 2 mi^2
     c) This translates to about $29 billion in potential incremental costs for the 6 core counties of the Midland Basin.
  2. **In some cases, shallow injection disposal appears to have "watered out" existing oil & gas wells.**
     a) This may prove a sizeable—and thus far, underappreciated—problem in the Delaware Basin

May 2018

San Andres Pressure Costs $13 Million Every 2 Square Miles

GUIDON ENERGY

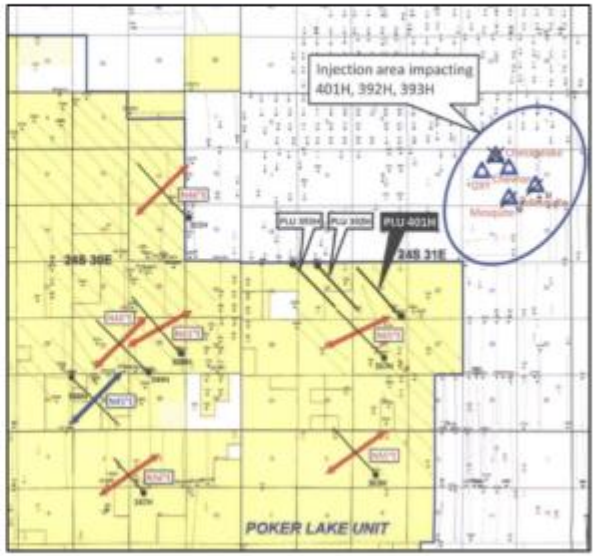


Recent Developments in Disposal Activities in Southeast New Mexico

- Delaware Mountain Group

With the expanded use of the Delaware Mountain Group for disposal by operators, there was an increase in reports of "waterflows" and abnormally high reservoir pressures observed in these formations in the vicinity of injection operations. Most notable of these events resulted in a Division case where an adjacent operator identified producing horizontal wells in the lower Brushy Canyon Formation that were impacted by injection in the upper formations of the Delaware Mountain Group.

This interference of production was attributed not to a single well, but to the concentration of several disposal wells with injection intervals within the Delaware.



June 2018

Cross-Border Water Arbitrage between TX and NM

Where politicians see theft…

"Texas is stealing New Mexico's water…If you put a whole bunch of straws in Texas and you don't have any straws in New Mexico, you're sucking all the water from under New Mexico out in Texas and then selling it back to New Mexico." --Aubrey Dunn, New Mexico State Land Commissioner (June 2018)

Source: Texas Tribune

Businesspeople see opportunity…

Solaris Water Midstream Acquires New Mexico Water Supply Business from Vision Resources, Inc. and Launches Major Expansion in the Delaware Basin

Jun 5, 2018, 9:30am EDT

• • •

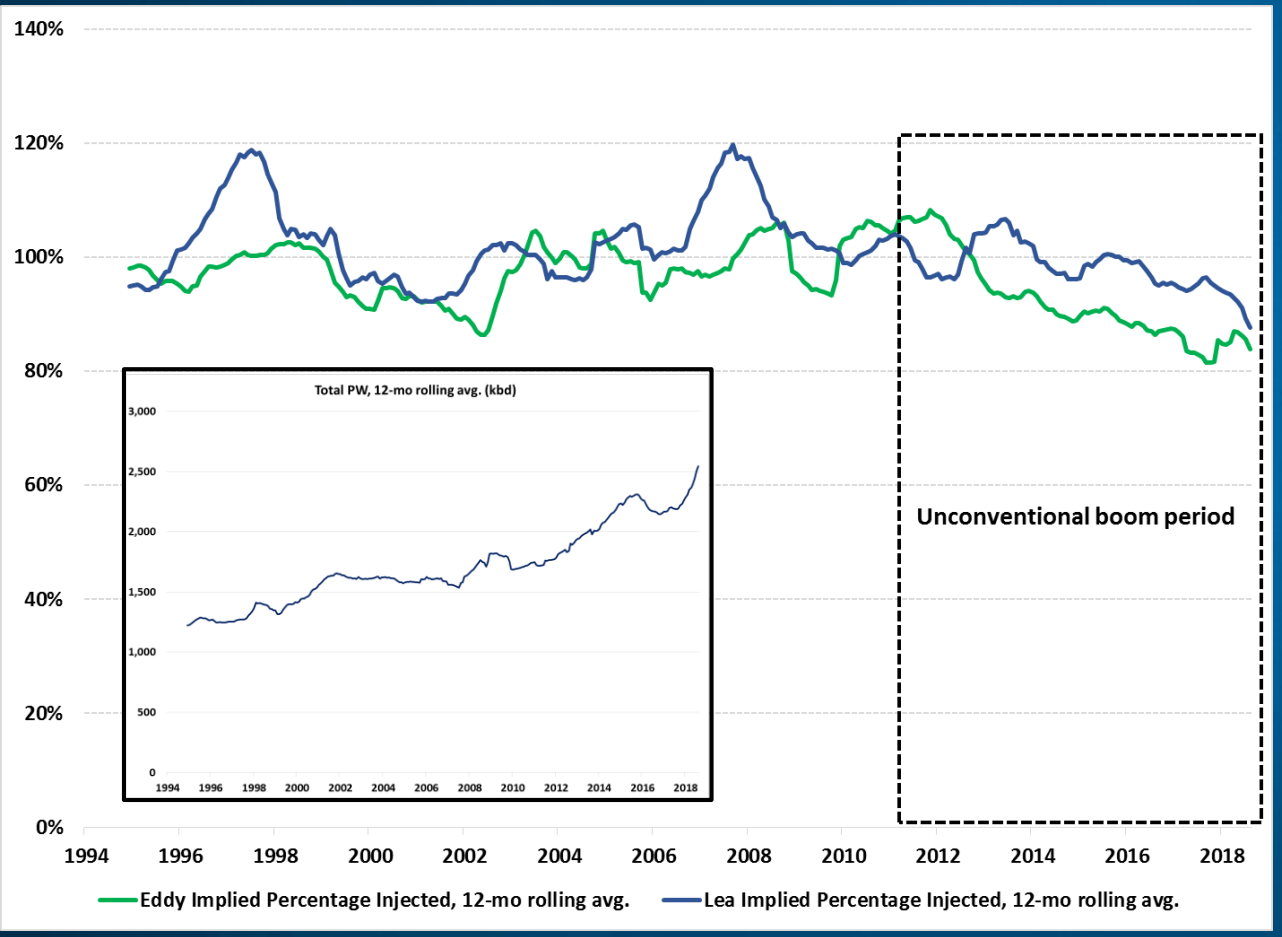
Major Expansion to Pecos Star System

Solaris Water also announced that it has started construction of a new 11-mile water supply line that will connect into its Pecos Star System. The high-capacity pipeline will add crucial, permanent water supply infrastructure to one of the most prolific areas in the Permian Basin and will be capable of transporting approximately 150,000 barrels of water per day from Loving County, Texas, to Eddy County, New Mexico. Construction of this strategic pipeline is underway. The line is expected to come into service in July 2018.

Source: Dallas Business Journal

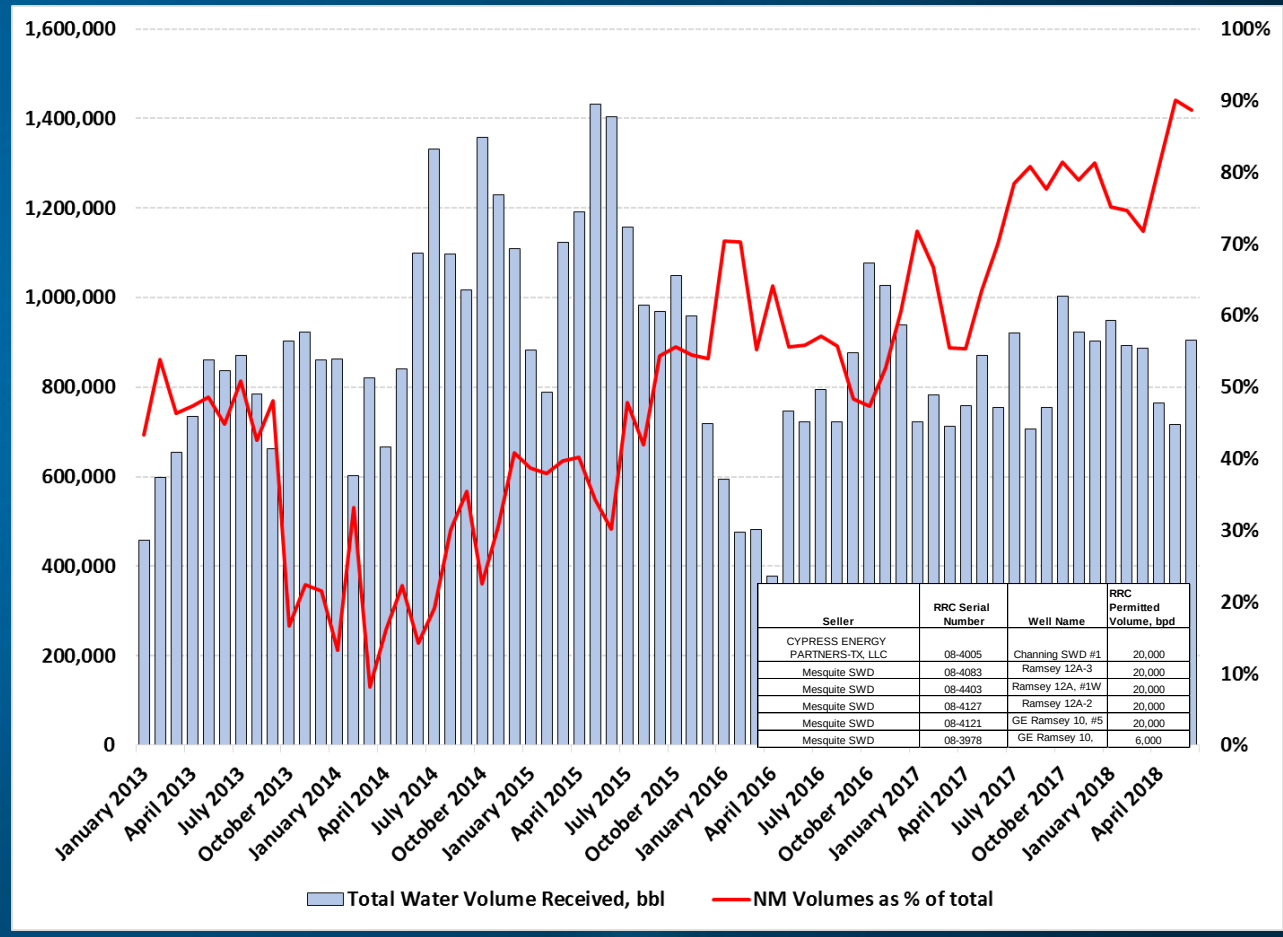
Is Texas Becoming New Mexico's Water Disposal Hinterland?

In-County Injection Proportion of PW Declining in Eddy & Lea Counties Despite Substantial Increases in PW Volumes



Source: NM OCD

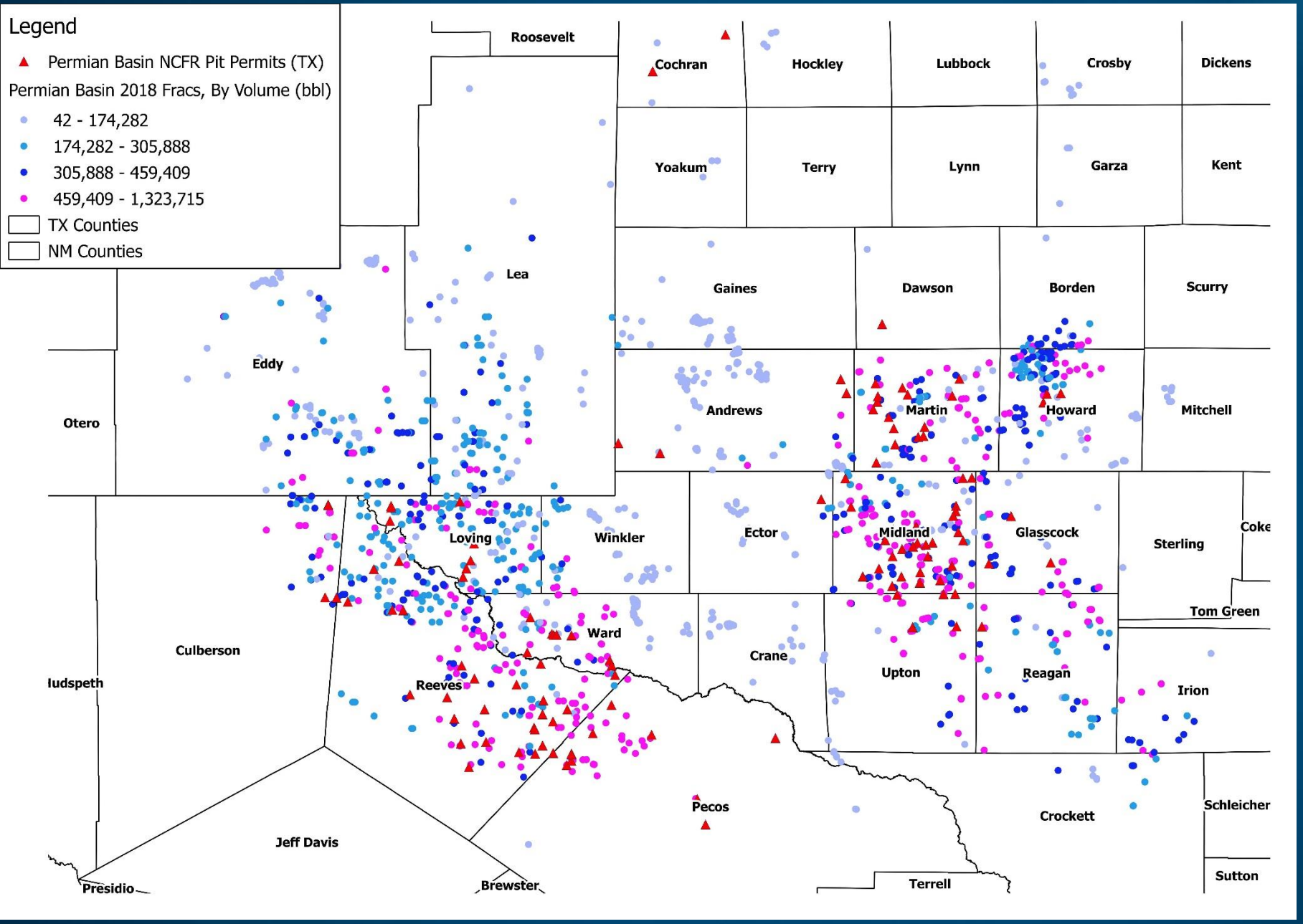
Anecdotal Well Data Suggests Rising Proportion of NM-Origin Water Headed Across the Border to Texas Disposal Wells



Seller	RRC Serial Number	Well Name	RRC Permitted Volume, bpd
CYPRESS ENERGY PARTNERS-TX, LLC	08-4005	Channing SWD #1	20,000
Mesquite SWD	08-4083	Ramsey 12A-3	20,000
Mesquite SWD	08-4403	Ramsey 12A, #1W	20,000
Mesquite SWD	08-4127	Ramsey 12A-2	20,000
Mesquite SWD	08-4121	GE Ramsey 10, #5	20,000
Mesquite SWD	08-3978	GE Ramsey 10,	6,000

Source: TX RRC

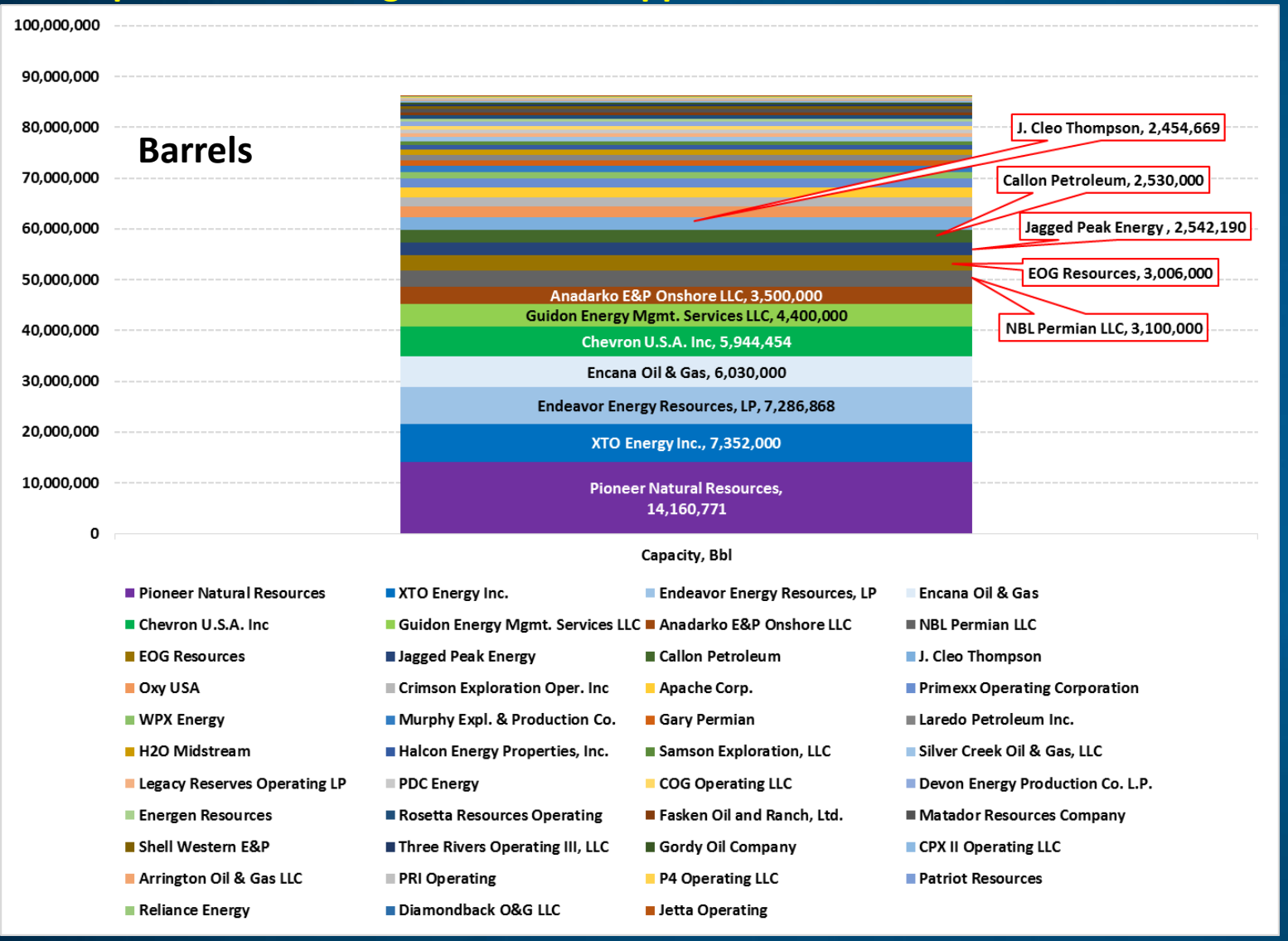
Oilfield Water: Frac Intensity & Recycling Infrastructure



- Nearly all of the these pits are non-commercial fluid recycling pits ("NCFR pits") where the operators primarily treat produced water for reuse in their own operations.
- The only "commercial" pit I find to date is H2O Midstream's Newton Facility in Howard County
- There are operational challenges to storing produced water, but increased interest in recycling activity suggests the number of commercial pits could rise sharply.
- This would be particularly true if produced water becomes a more widely-traded frac fluid feedstock.
- Trading of PW between parties is currently limited and generally on ad hoc basis.

Companies Are Gearing Up to Recycle More Produced Water

Non-Commercial Fluid Recycling Pit Capacity Companies Have Sought Texas RRC Approval For



Company-level Permian Recycling Plans

- **Apache**—"…by year-end, we feel like we'll be able to utilize about 80% of recycled water for our fracs [*at Alpine High*]." (2Q2018 Earnings Call)
- **Devon**— "~80% of total water used in operations is recycled" [*NM Delaware Basin*] (EnergyPlex Presentation, 2018)
- **Encana**—"We expect average 40% recycled water use in the basin with some cubes as high as 80%..." (2Q2018 Earnings Call)
- **Guidon Energy**—"Once infrastructure was built, we began using 13/87 produced/fresh mix for all fracs." (May 2018 Presentation)
- **Noble**—"And by the end of the year [2018], I'd expect over 30% of the water used in our fracs to be recycled produced water." (2Q2018 Earnings Call)
- **Pioneer Natural Resources**—"Right now, we're increasing our reuse volumes of our produced water to the point where it's going to represent 15% to 20% of our water volumes in the fourth quarter this year." (2Q2018 Earnings Call)

Source: Texas RRC

Can Greater Recycling Help Optimize the Oilfield Water Investment Cycle?

CAPEX to Dispose of 50 kbd of Produced Water

Option 1: Delaware Sands SWD

2 wells @ 25 kbd per well
X
$5 million-to-$6 million per well
$10 million-to-$12 million

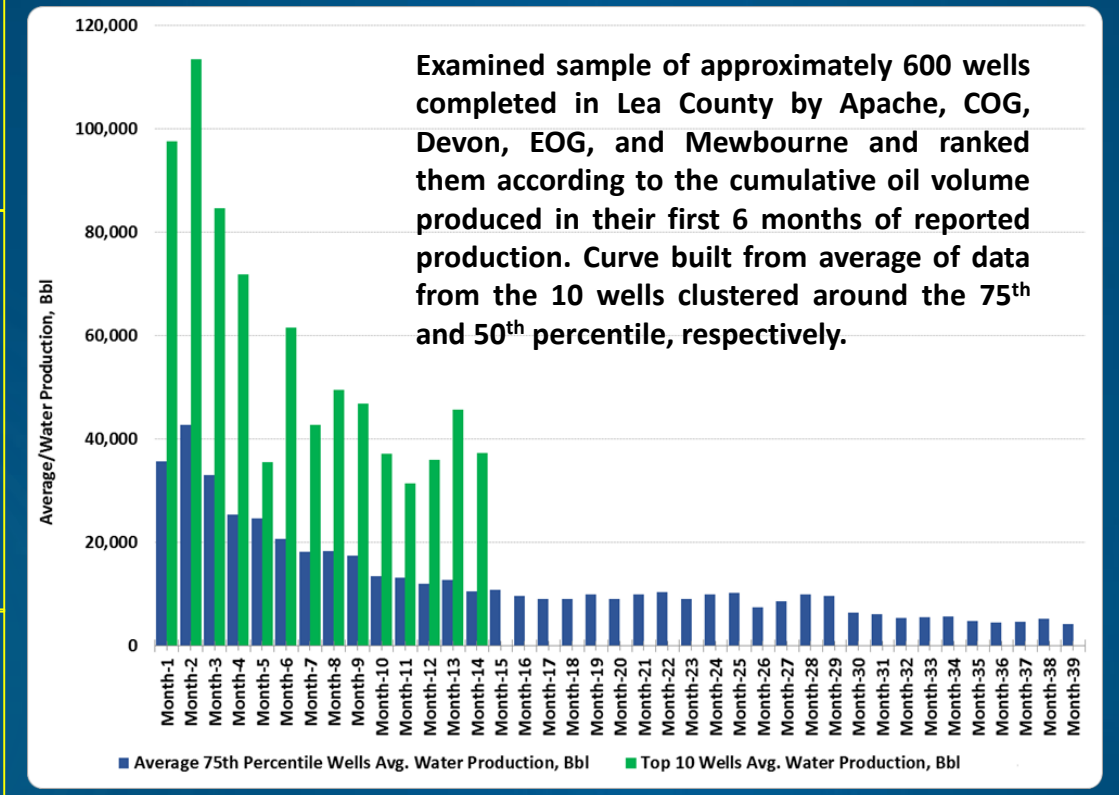
Option 2: Devonian/Ellenburger SWD

2 wells @ 25 kbd per well
X
$8 million-to-$12 million per well
$16 million-to-$24 million

Option 3: Recycling

1000 kb pond capacity @ $1.25/bbl of built storage
+
$1,000k for process units
$2.25 million

Water Production Profile of Top-Tier Wells in Lea County, NM



Source: NM OCD, Author's Analysis

- CAPEX differences favor recycling. OPEX parameters will vary depending on scale and quality of incoming water, as well as E&P customer needs.
- The core question is: do recycling investments early in a play's development when frac'ing is most intense and the demand for feedstock water is highest help defer SWD investments that can then be made later when PW flows are more predictable and capital and capacity optimization are easier to do?

Tradable Produced Water: The new "WTS?"

Thought-Provoking Idea

- "WTS" would currently be the abbreviation for West Texas Sour, a crude oil with an API gravity of 30.2 and sulfur content of between 1.5% and 2.8% by weight.
- In the Permian oilfield water world, there is a case to be made for what we can somewhat facetiously call the new WTS—as in "West Texas Salty" for the highly saline produced waters that flow up from wells in the region.
- Instead of API gravity and sulfur content, perhaps the quality specs for this hypothetical benchmark for recyclable produced water would be XX ppm total suspended solids, XX ppm of iron and other precipitate-forming ions, and MPN levels of XX * 10^{x} or less of bacteria.

At least one Texas-focused operator is already contemplating a world in which produced water carries a commercial price tag.

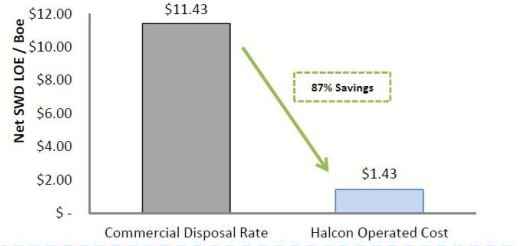
Halcón Resources Investor Presentation
February 28, 2018

Halcón Field Services
Water Management Advantages

Key Infrastructure for Cost Control

- Operational Advantages
  - Eliminates dependence on 3rd party sources for water disposal and completions
  - Simplifies operations to handle and source all water within our own field
  - Critical to control own destiny with regards to infrastructure, especially water infrastructure
- Value of these assets growing rapidly as production and expansion of capacity continues

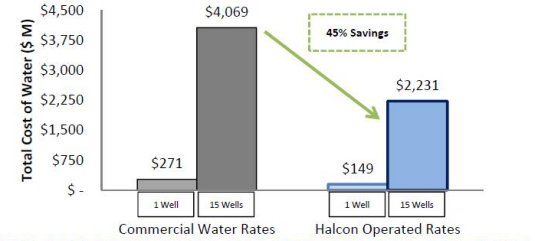
Hackberry Draw SWD LOE Cost Control Example (1,2,6)



Estimated savings of ~$1.7 MM /well during first year of production

Hackberry Draw Water Recycling Facility

Water for Completions Cost Control (3,4,5,6)



Estimated savings of ~$1.8 MM /rig/year (2)

(1) Assumes commercial water disposal costs of $2.00 / bbl of water.
(2) Assumes Halcon Field Services handles produced water for $0.25 / bbl of water.
(3) Assumes blended water use of 75% recycled produced water and 25% fresh water.
(5) Assumes commercial water sourcing costs of $0.35 / bbl for produced water and $0.50 / bbl for fresh water.

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(5) Assumes commercial water sourcing costs of $0.35 / bbl for produced water and $0.50 / bbl for fresh water.

A Few Permian Oilfield Water Predictions

A. **Within 12 months from today (start date August 2018)**

- A major Permian-focused water midstream firm goes public or has a similarly large liquidity event
- At least 3 additional large private equity companies enter the space
- At least 3 sizeable (80 kbd+ avg. actual volume handled) water midstream firms in the Permian will be acquired by a larger player

B. **Within the next 24 months**

- There will have been a billion-dollar oilfield water transaction in the Permian
- At least five Permian-focused entities other than Pioneer Water Management will be transporting and injecting 500 kbd or more of produced water

C. **Within the next 36 months (i.e. by August 2021)**

- At least 4 million bpd of incremental produced water (relative to August 2018) must be handled

Source: Pinterest

Cutting-Edge Texas Groundwater and Oilfield Water Research

- Gabriel Collins, "*What Does it Take to Create a Billion Dollar Oilfield Water Midstream Company?*," PWS Permian Basin 2018 Symposium, 9 August 2018, Midland County Horseshoe Arena & Pavilion, https://texaswaterintelligence.files.wordpress.com/2018/08/collins_billion-dollar-oilfield-water-company_14-august-20181.pdf
- Gabriel Collins, *"Economic Valuation of Groundwater in Texas,"* Texas Water Journal, Vol. 9, No.1, 2018 (50-68), https://twj.media/economic-valuation-of-groundwater/, (peer reviewed)
- Gabriel Collins, "*Groundwater Valuation in Texas: The Comparable Transactions Method*," Baker Institute Report no. 03.20.18, Baker Institute for Public Policy, Houston, Texas, https://www.bakerinstitute.org/research/groundwater-valuations-texas/
- Gabriel Collins, "*Valuation of Groundwater In Place at a Texas Frac Water Supplier*," Issue brief no. 12.07.17. Baker Institute for Public Policy, Houston, Texas, https://www.bakerinstitute.org/research/valuation-groundwater-place-texas-frac-water-supplier/
- Gabriel Collins, ""*Oilfield Produced Water Ownership in Texas: Balancing Surface Owners' Rights and Mineral Owners' Commercial Objectives*," February 2017, Baker Institute for Public Policy, Houston, Texas, https://www.bakerinstitute.org/media/files/files/23bd889f/CES-pub-ProdWaterTX-020817.pdf
- Gabriel Collins and Hilmar Blumberg, *"Implementing three-dimensional groundwater management in a Texas groundwater conservation district,"* Texas Water Journal, Vol. 7, No.1, 2016 (69-81), https://journals.tdl.org/twj/index.php/twj/article/view/7037/pdf_17 (peer reviewed)
- Gabriel Collins, "*Blue Gold: Commoditize Groundwater and Use Correlative Management to Balance City, Farm, and Frac Water Use in Texas*," 55 Nat. Resources J. 441 (2015). (peer reviewed)

Appendix

What Might The Numbers Behind a Billion Dollar Oilfield Water Midstream Entity Look Like?

Integrated System

Estimated water volumes to justify a billion USD enterprise valuation***

EBITDA Multiple	Frac Sourcewater, Kbd	Produced Water Gathering, Kbd
5.0	240	600
6.5	185	462
7.5	160	400
10.0	120	300

In other words, approximately 550-to-650 thousand bpd of water.

In Fiscal Year 2017, the City of Midland's average combined daily water usage and sewage treatment volume was approximately 521 thousand bpd.

What Might The Numbers Behind a Billion Dollar Oilfield Water Midstream Entity Look Like?

Estimated water volumes to justify a billion USD enterprise valuation***

Produced Water-Only

475 kbd

(assume $0.75/bbl rate)

@7.0X EBITDA multiple

Sourcewater-Only

Texas-side:

1,500 kbd

(assume $0.50/bbl gross price)

Premium sales into SE NM

425 kbd

(assume $1.25/bbl gross price)

@ 5.5X EBITDA multiple