

Spatiotemporal assessment of tight-oil produced water (TPW) in West Texas: quantity, origin, reuse and forecast

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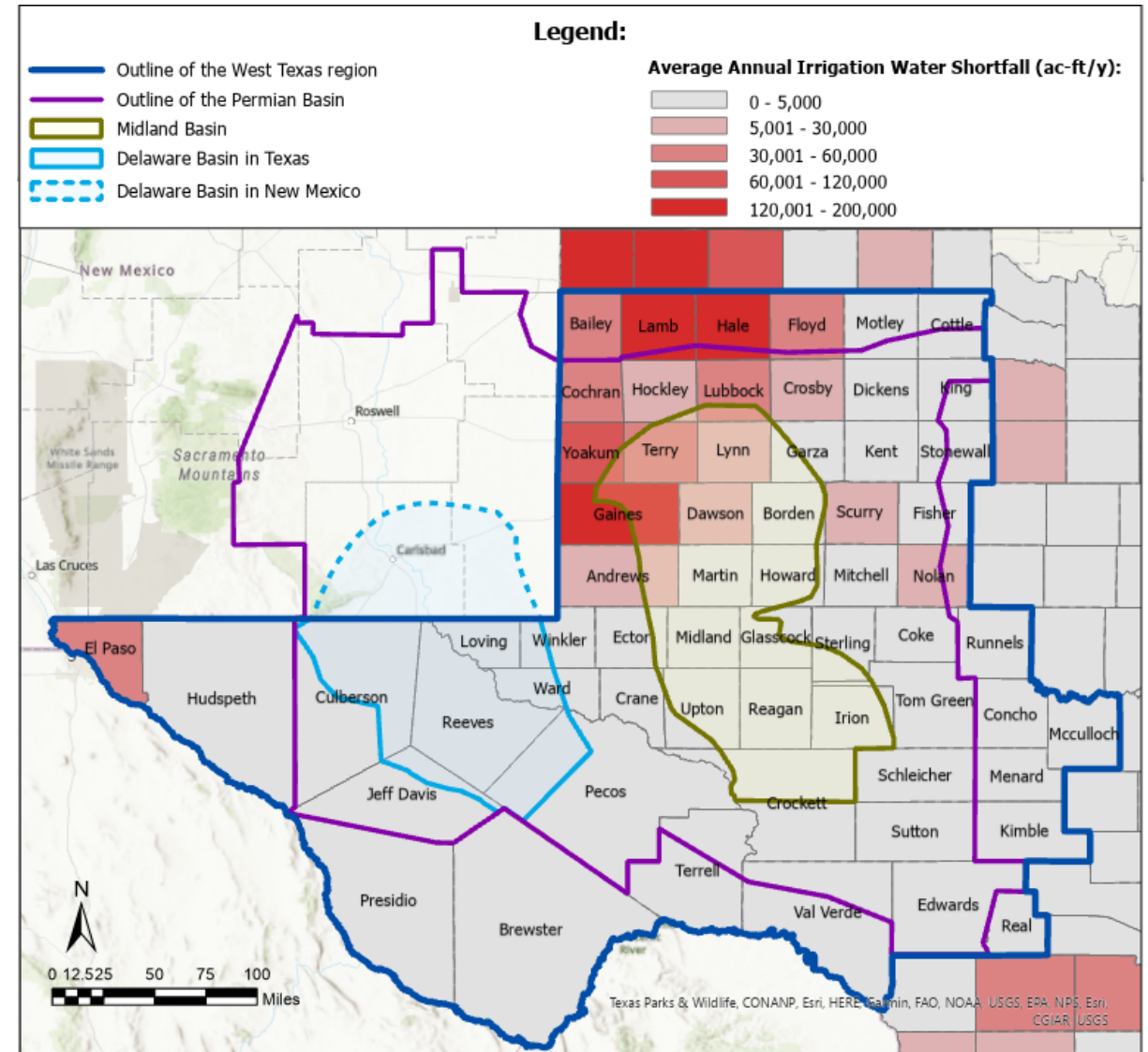
TxPWC Annual Membership Conference 2024

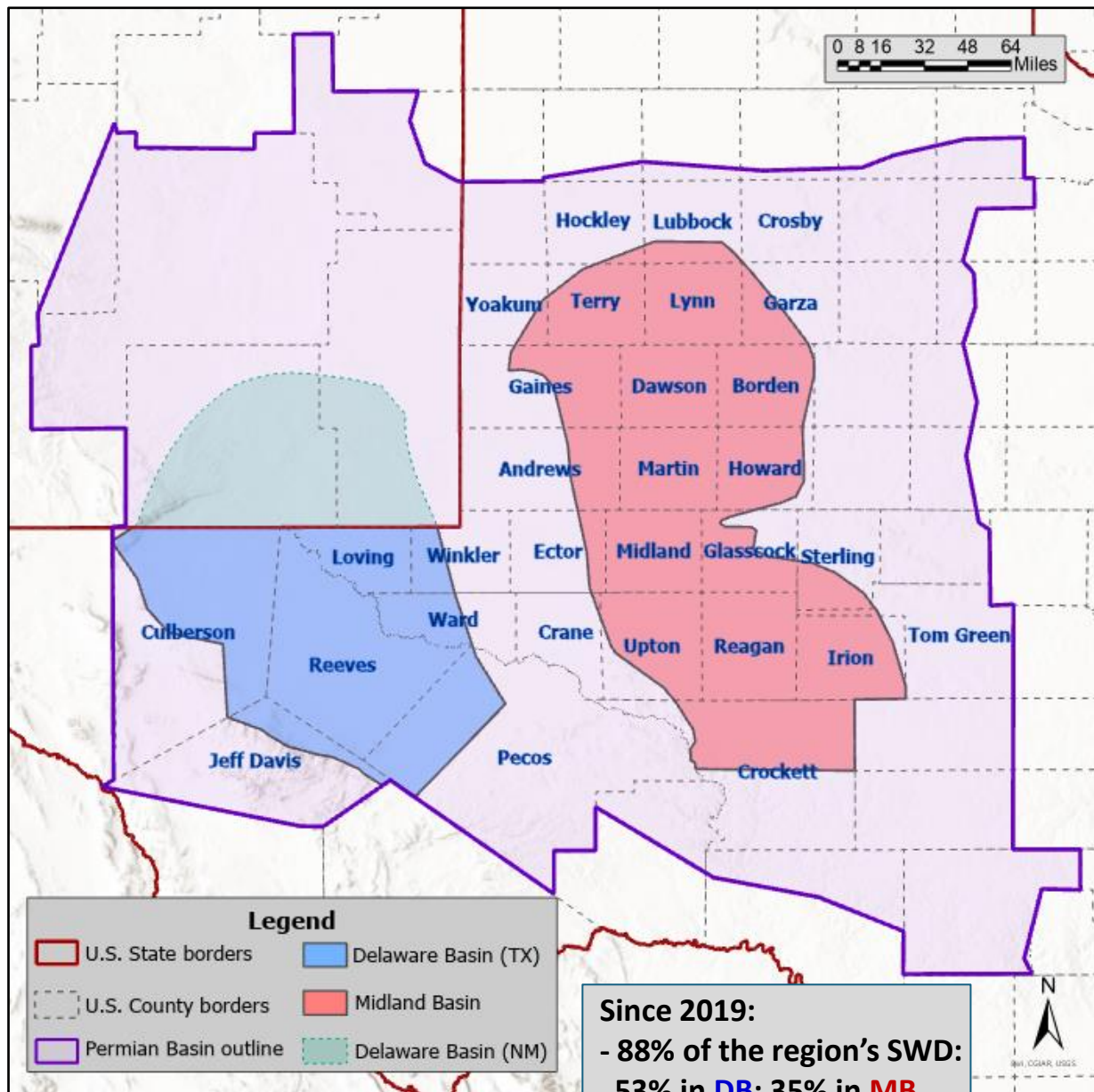
September 10th, 2024



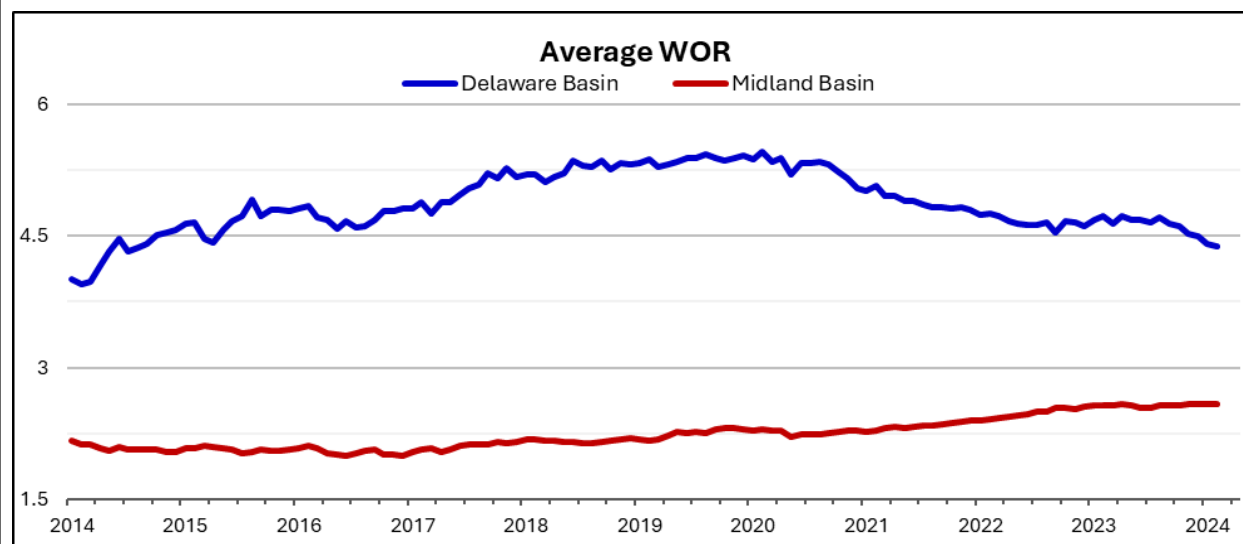
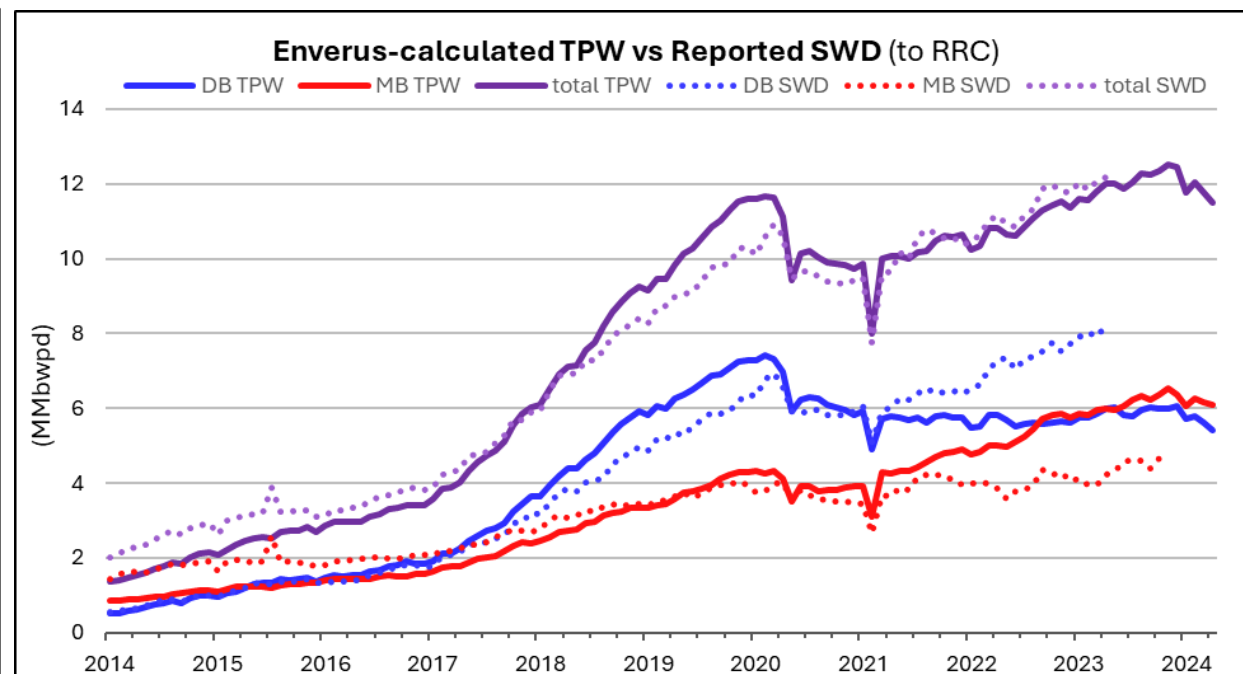
Reasons to focus on the Study Area:

- a. Increase in Induced Seismicity due to SWD
- b. Disposal of tight-oil produced water (TPW) in SWD wells
- c. 63% of Texas's total SWD injection in 2019 (source:TWDB)
- d. Annual water shortfall of 1.05 million ac-ft/y (87% in irrigation)
- e. 30% of Texas' water shortfall in irrigation, leading up to 2070
- f. Groundwater supply to drop by 43% in 2070, mostly due to irrigation
- g. The region's Produced Water has potential for beneficial reuse

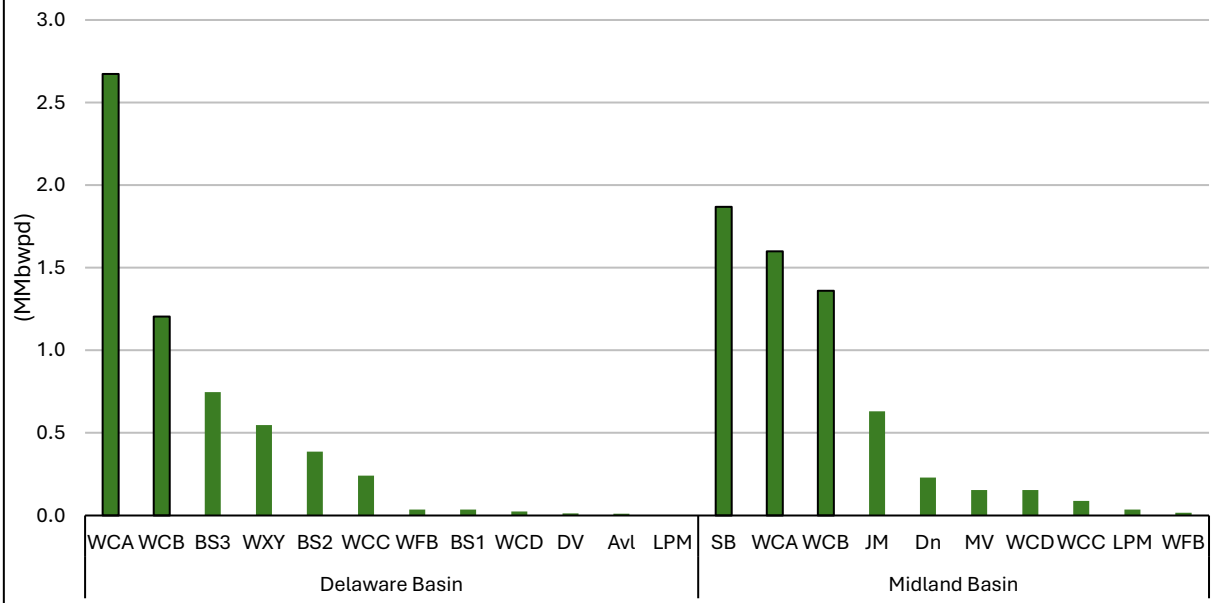




Since 2019:
 - 88% of the region's SWD:
 53% in **DB**; 35% in **MB**
 - 98% of Rig activity:
 38% in **DB**; 59% in **MB**

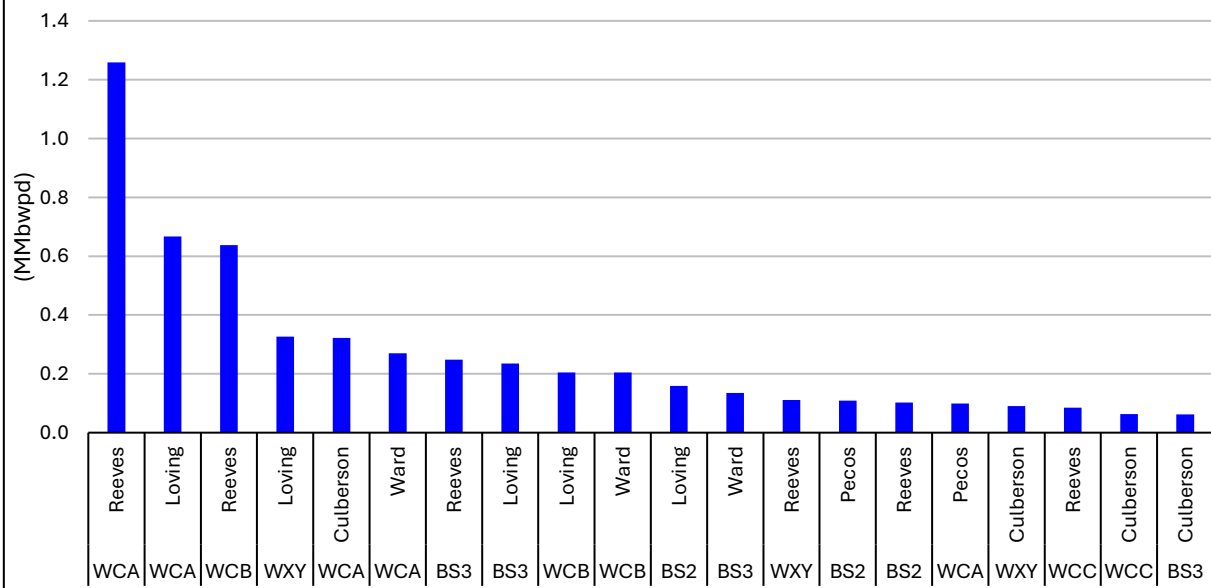


Water-producing tight-oil geological intervals (year 2023)

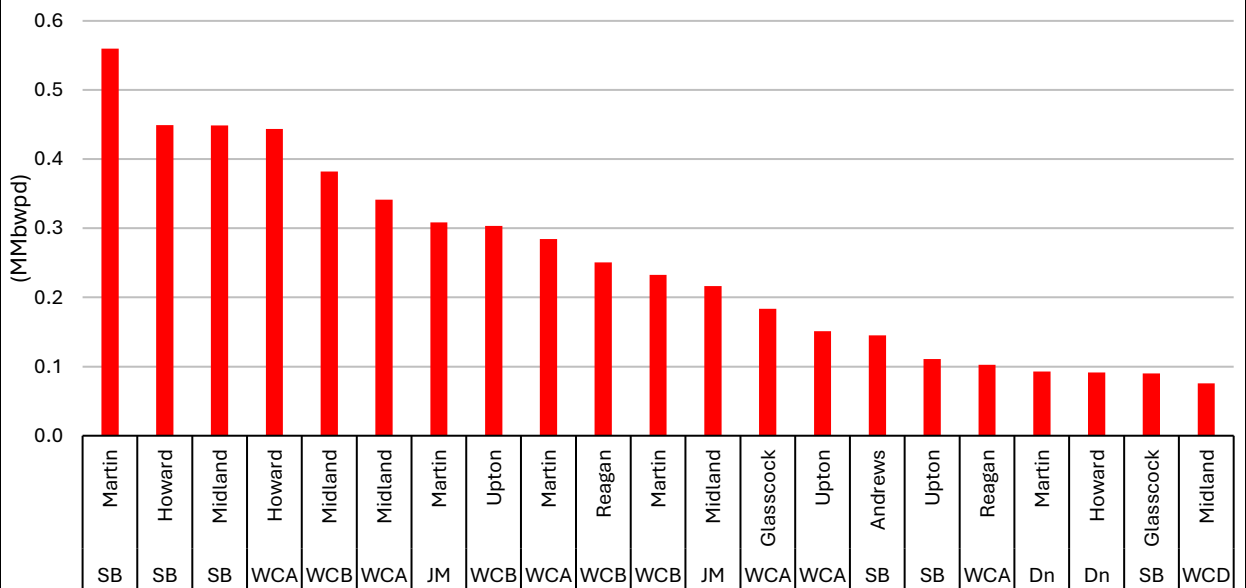


abbreviation	TTU Interval
Avl	Avalon
BS1	1st Bone Spring
BS2	2nd Bone Spring
BS3	3rd Bone Spring
Dn	Dean
DV	Delaware Vertical
JM	Jo Mill
LPM	Lower Pennsylvanian & Mississippian
MV	Midland Vertical
SB	Spraberry
WCA	Wolfcamp A
WCB	Wolfcamp B
WCC	Wolfcamp C
WCD	Wolfcamp D
WFB	Woodford & below
WXY	Wolfcamp XY

Delaware Basin: major TPW origins (91% TPW; year 2023)



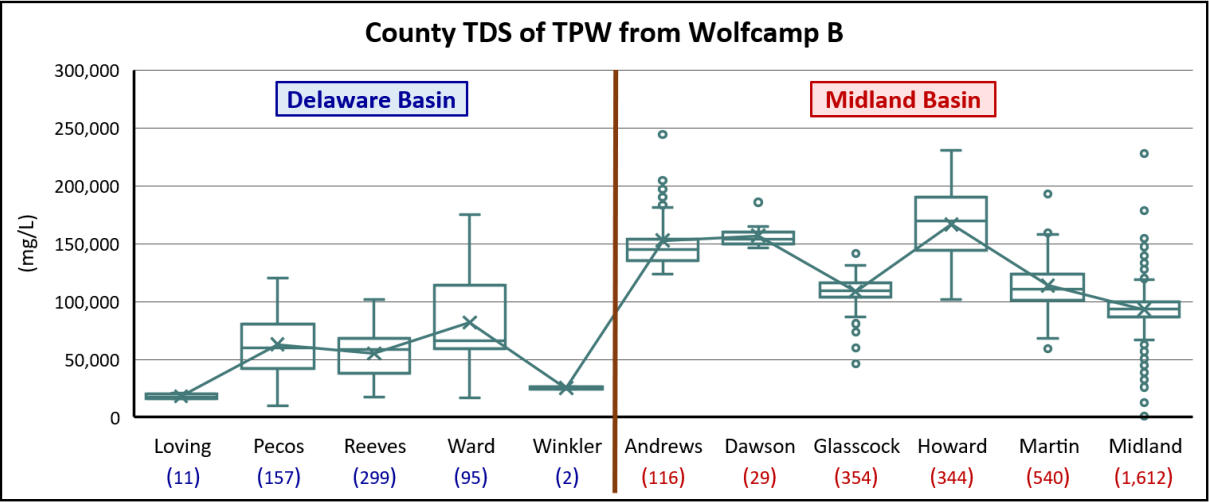
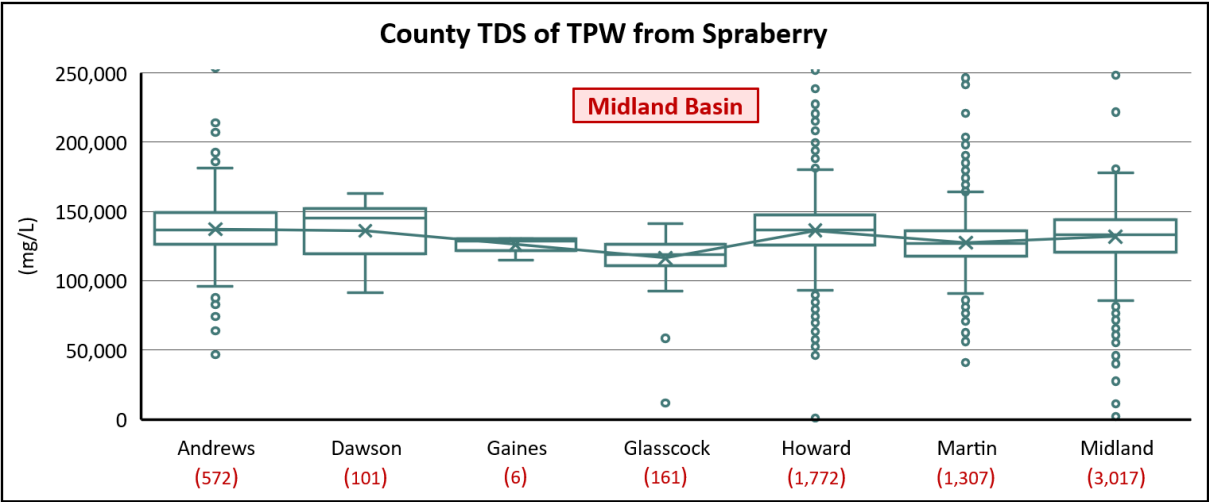
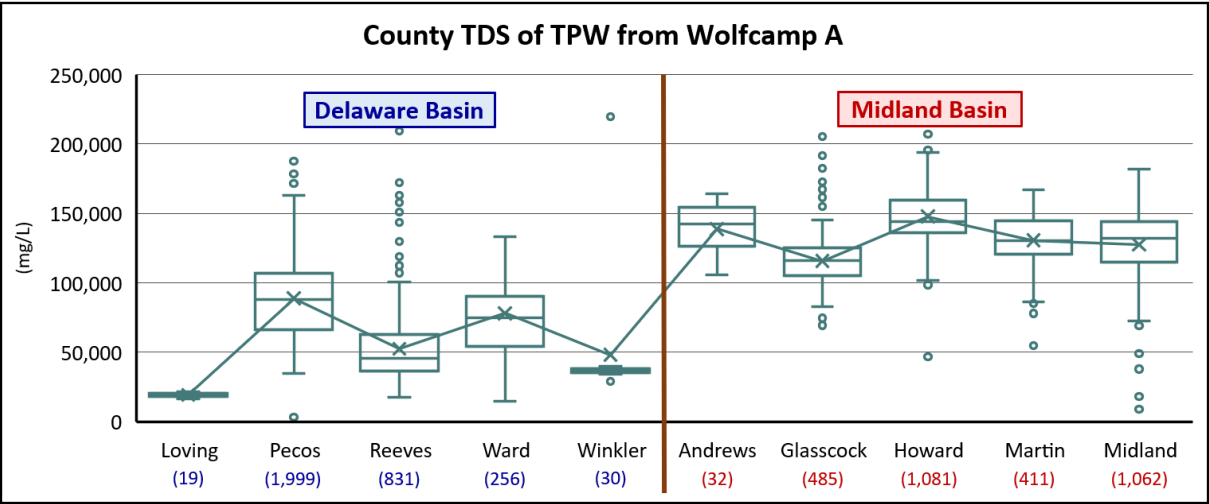
Midland Basin: major TPW origins (86% TPW; year 2023)

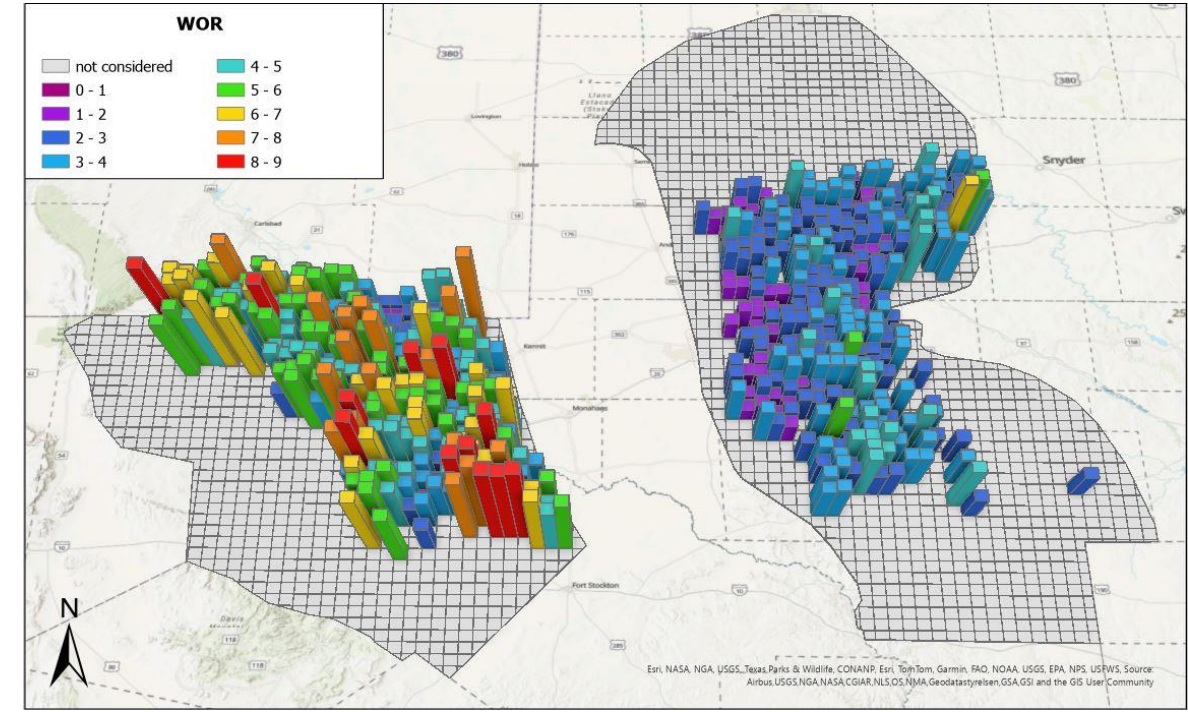
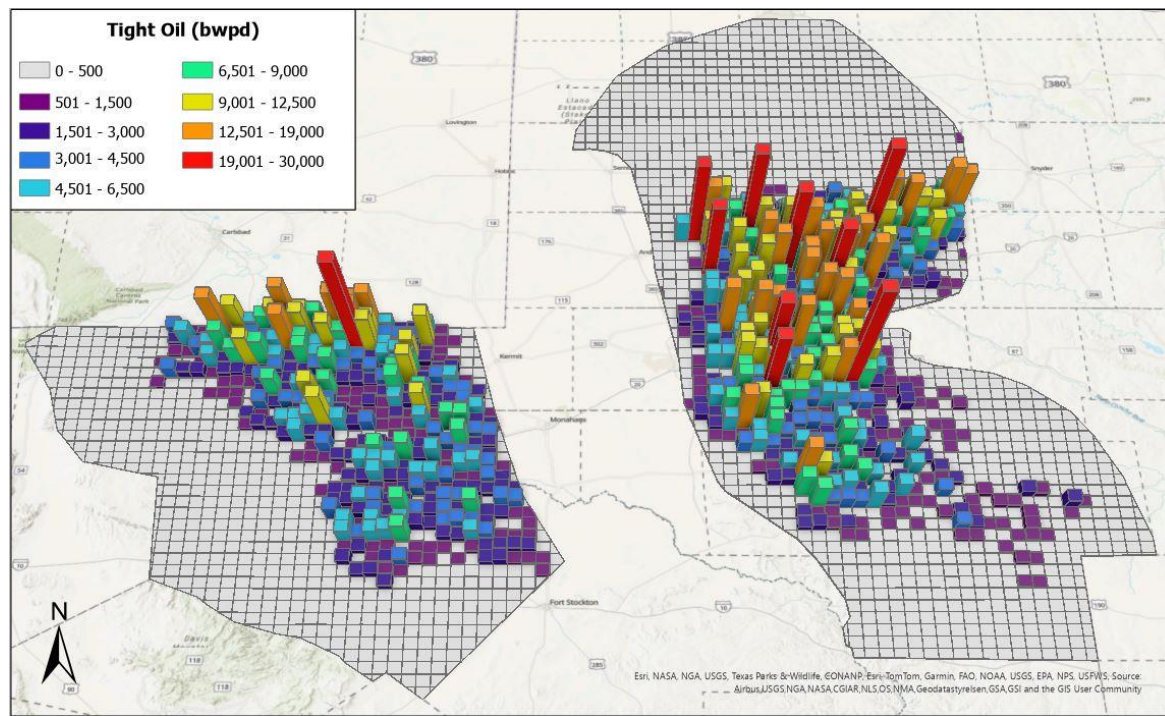
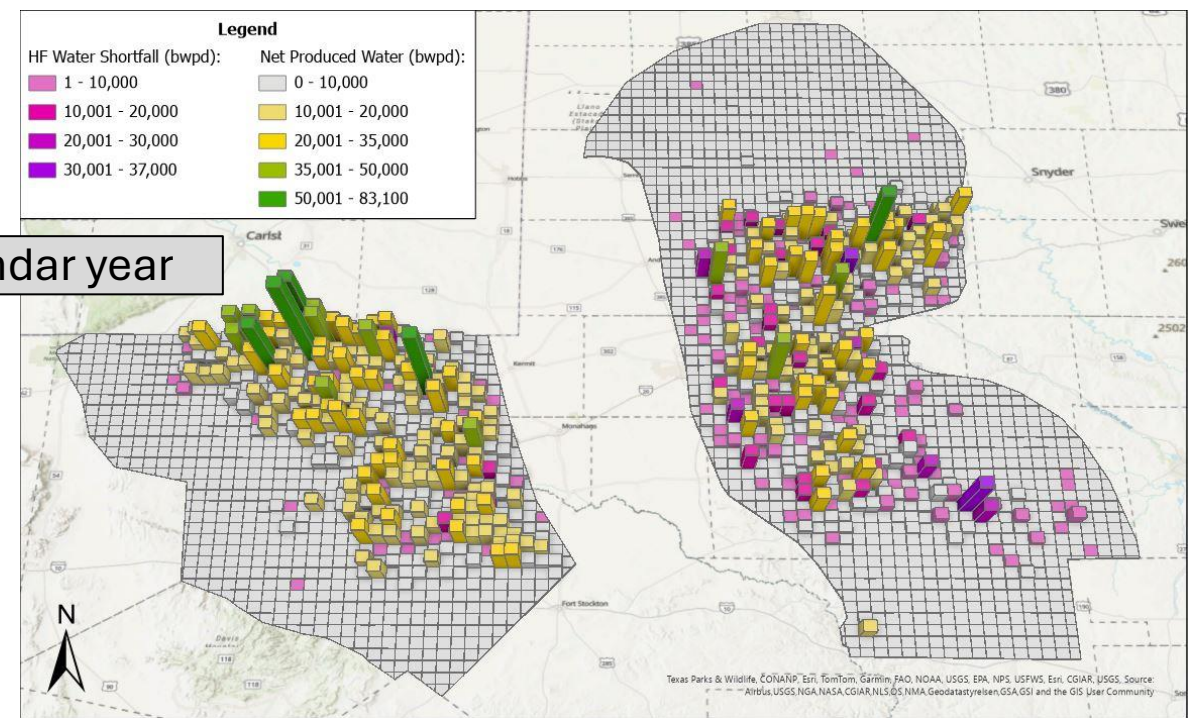
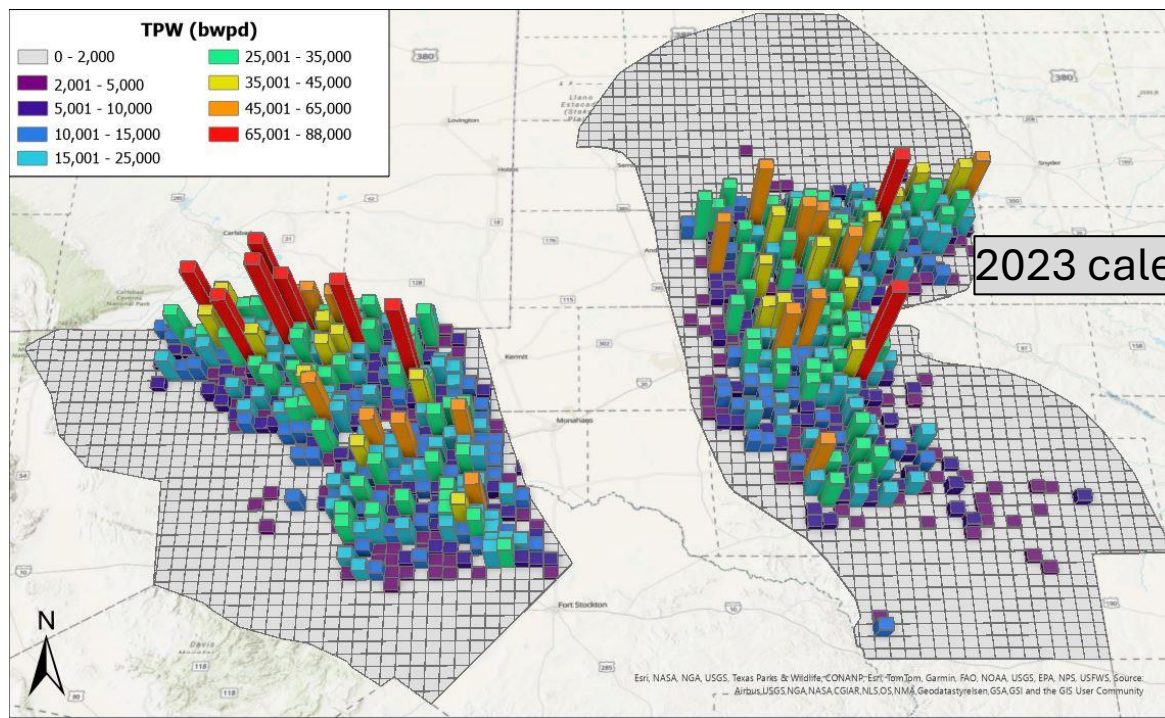


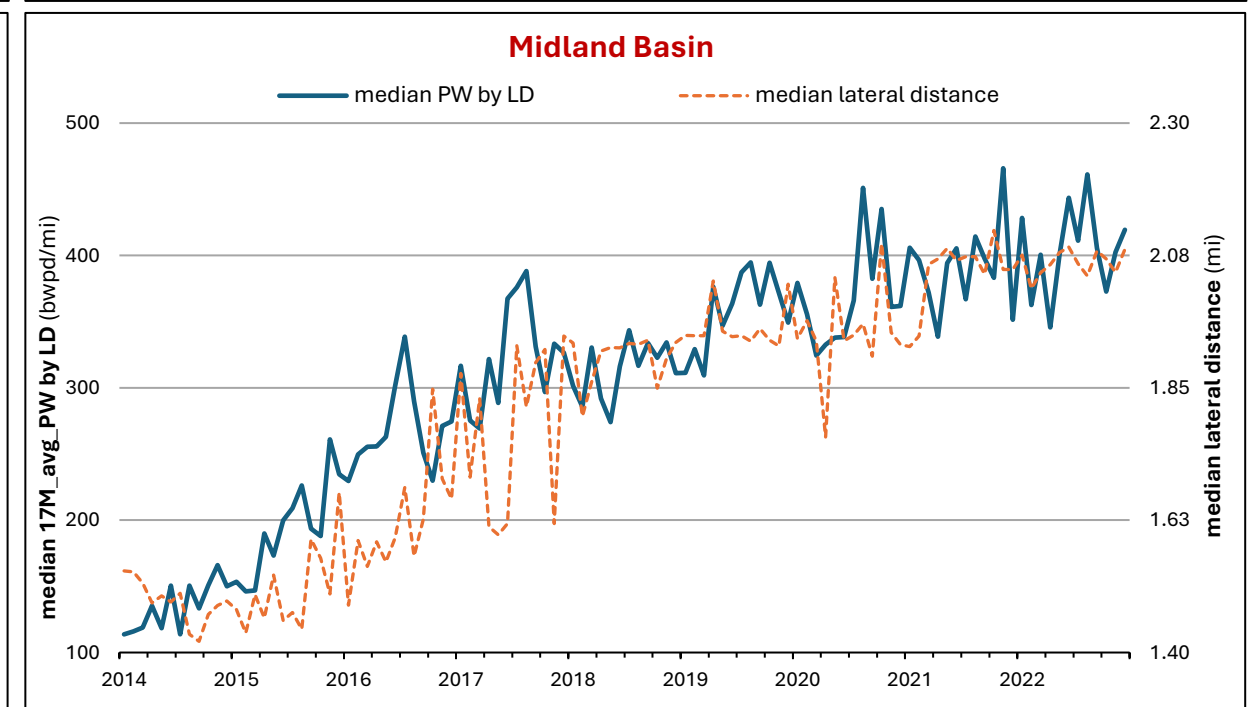
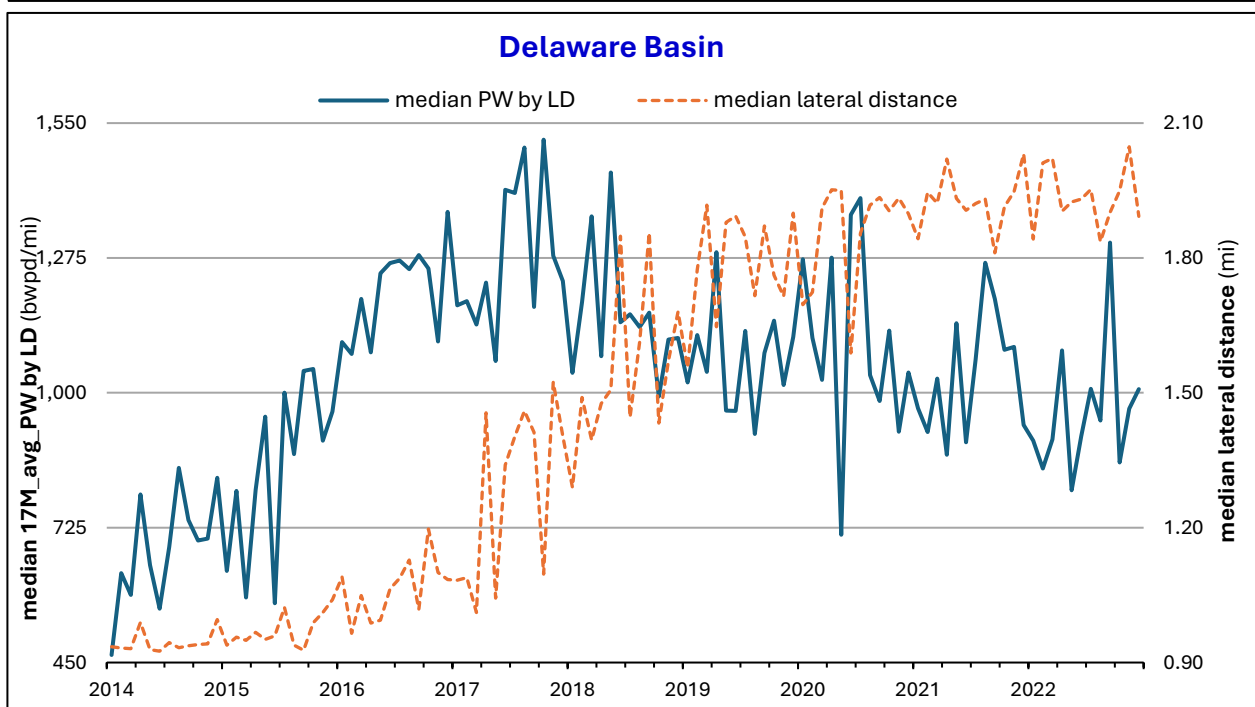
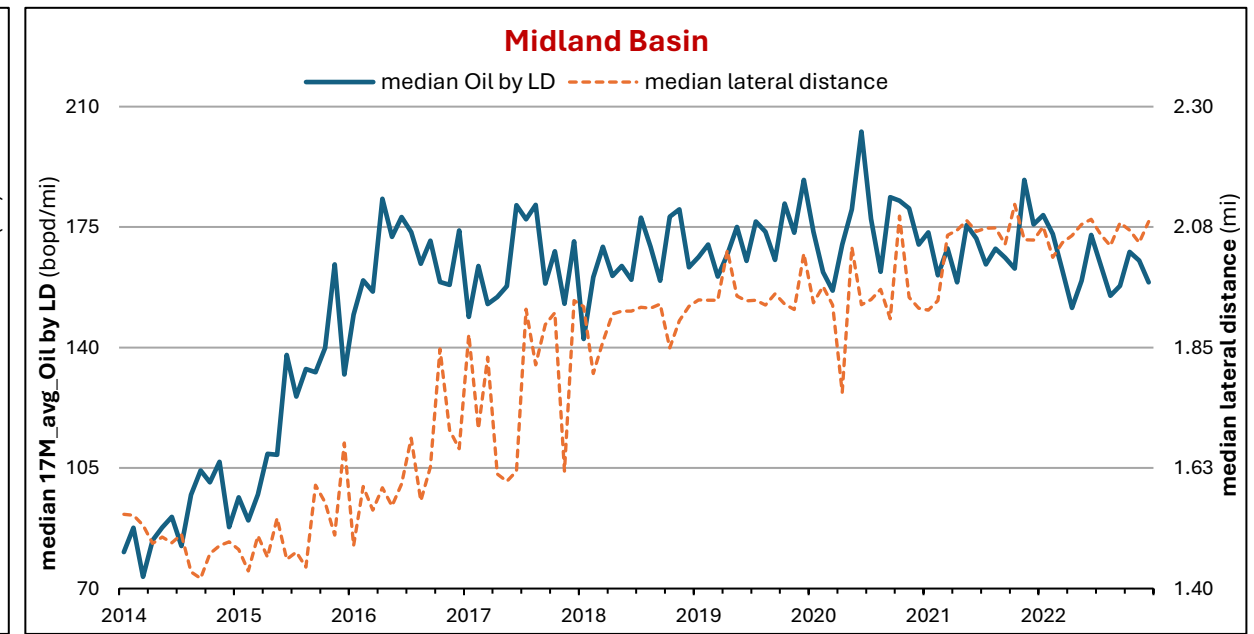
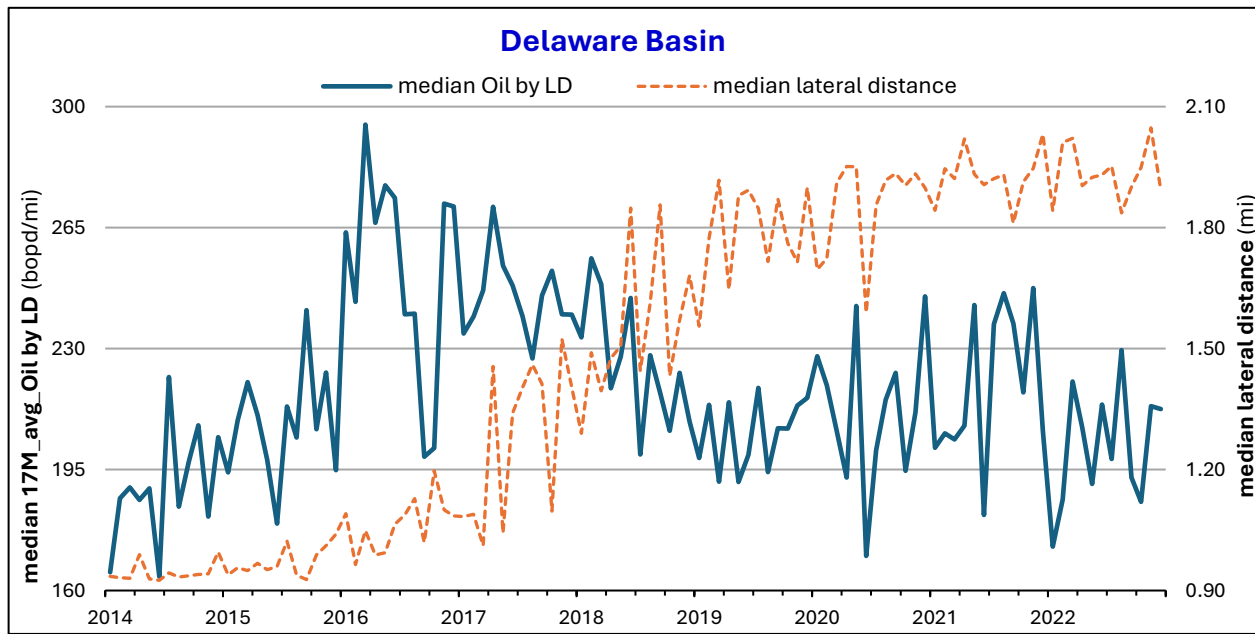
Chemical Composition

The Delaware Basin tends to be the better basin for TPW treatment, mainly due to containing significantly less total dissolved solids (TDS) with a median concentration of 71,681 mg/L.

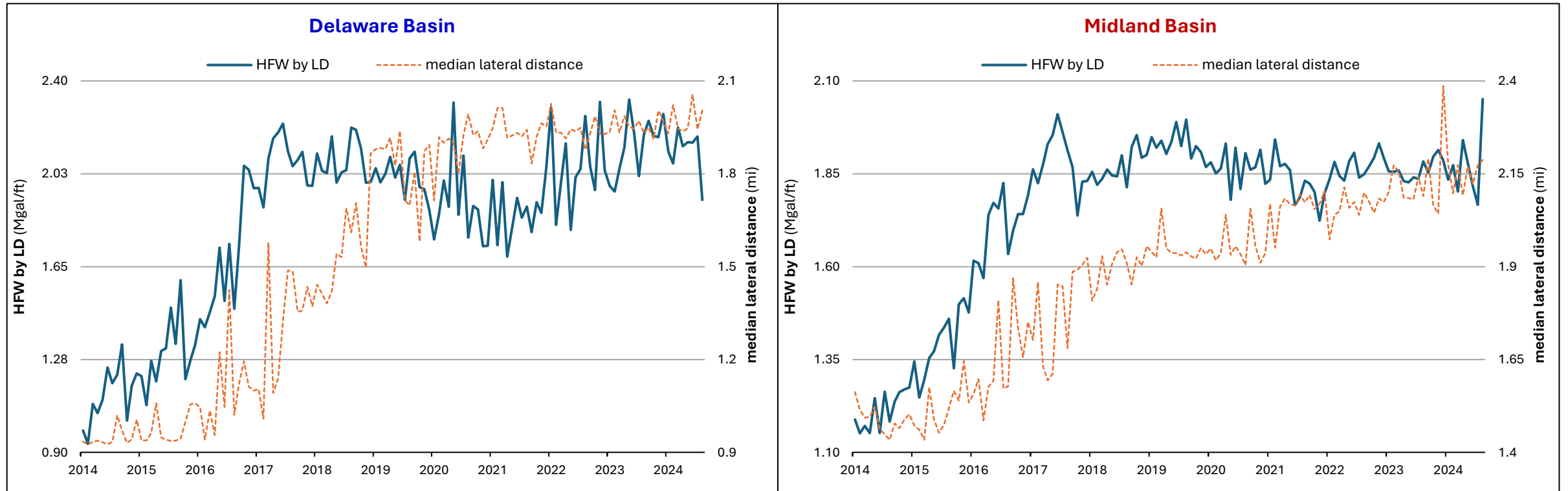
Chemical Property	Seawater	Delaware Basin (6,182 samples)	Midland Basin (23,296 samples)
		50 th percentile	50 th percentile
pH	8.15	6.68	6.23
Hardness, mg/L	6,345	3,426	9,807
Total dissolved solids, mg/L	34,482	71,681	129,293
Alkalinity (as mg/L CaCO ₃)	116	61	91





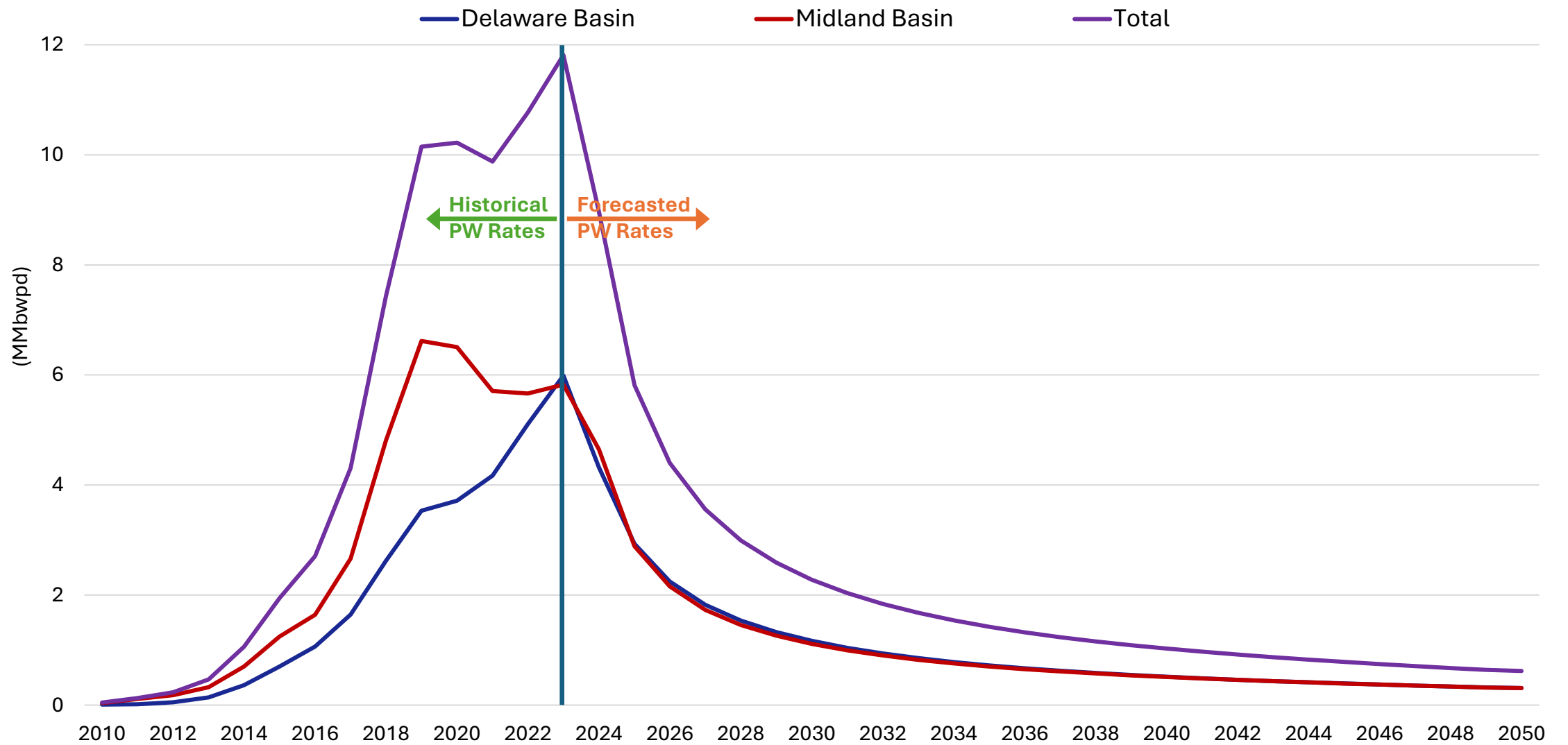


Hydraulic Fracturing Water Demand in Recent Laterals



Almost the same HF water demand across most tight-oil producing counties

PW Forecast for Active Horizontal Wells

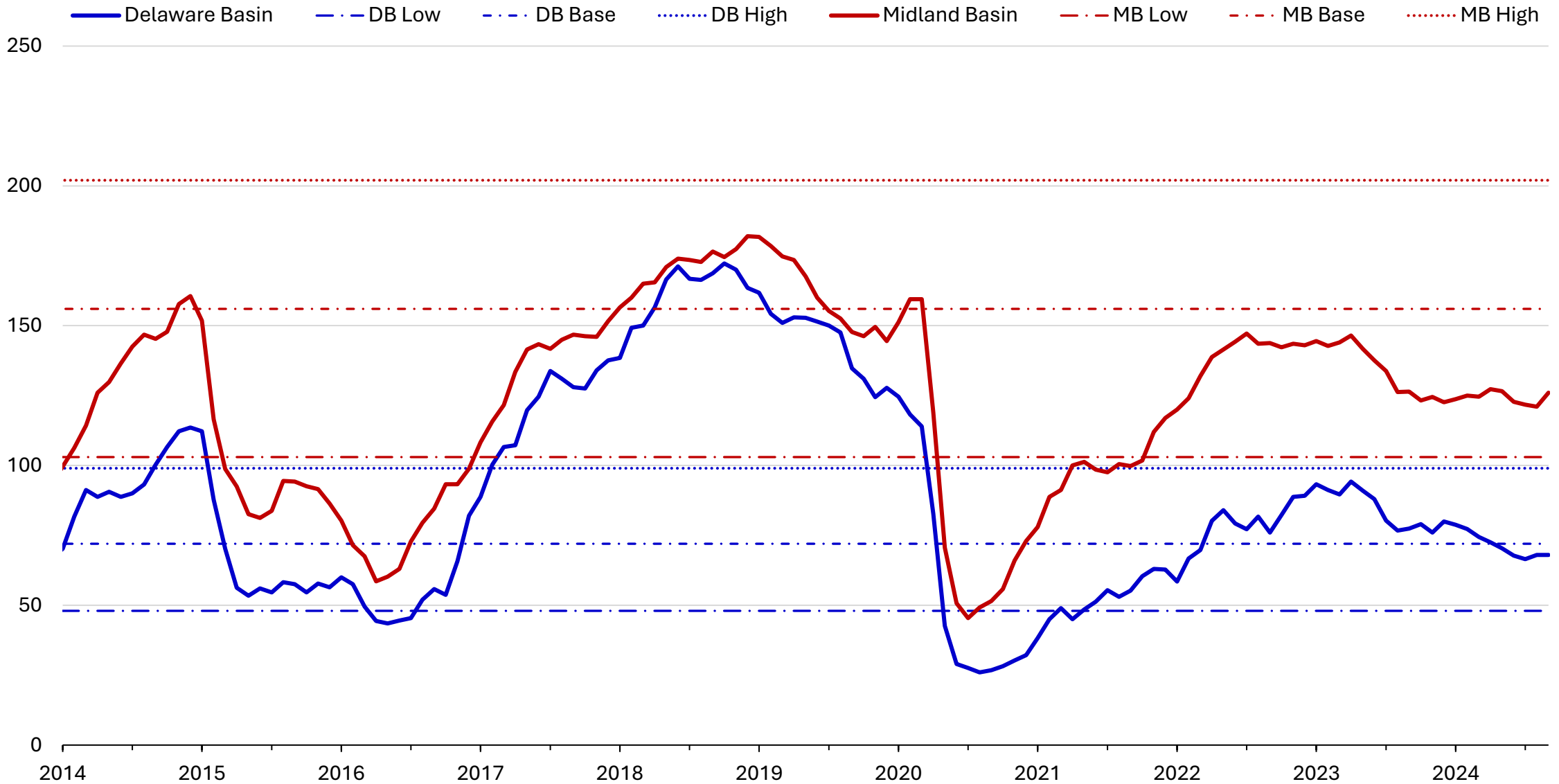


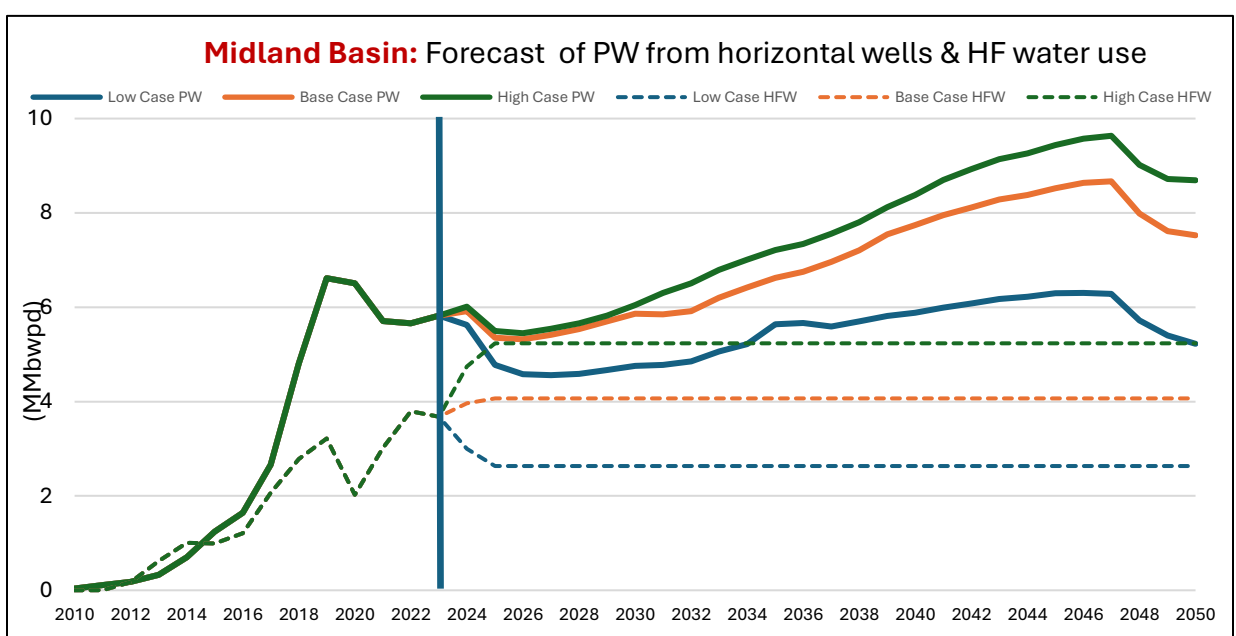
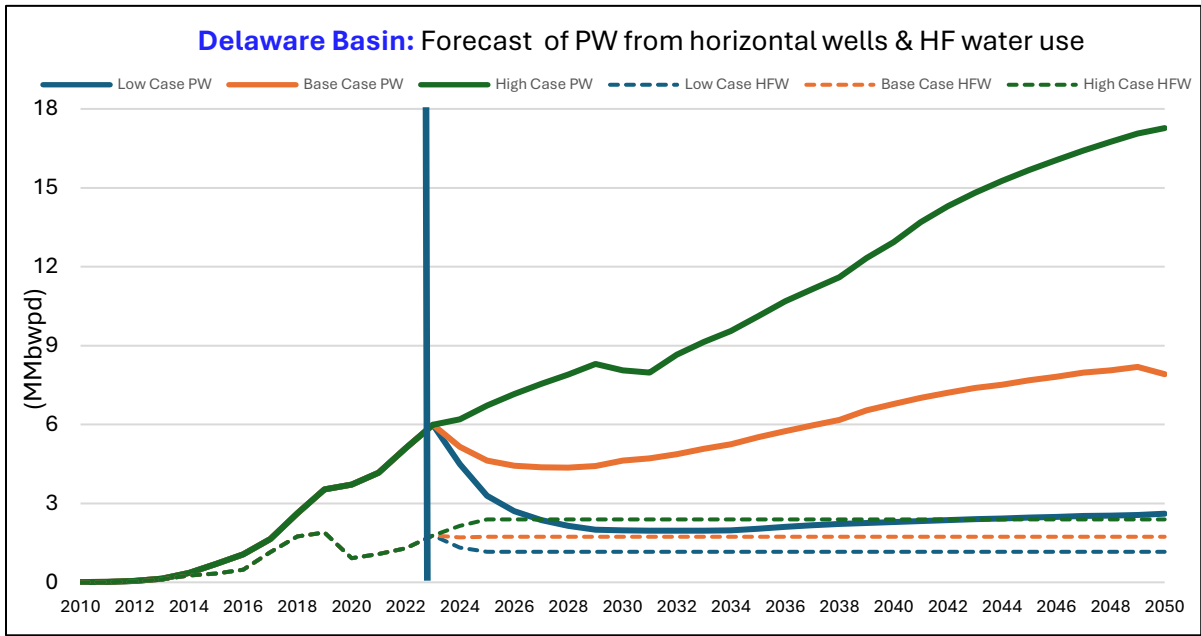
Production Forecast

Updates to forecast from the previous TxPWC report (Smith et al. 2022; Eyitayo et al. 2023):

- The number of layers increases from 8 different layers for horizontal well development to 15 layers, increasing the number of wells drilled.
- New wells drilled between 2022 and 2024 were incorporated; hence, type curves are based on more horizontal wells with longer lateral sections (2-3 miles)
- The decline Arp's parameter is optimized for representative trends based on updated production data.
- The rig count and drilling rate have not changed from the previous report. An average value of 18 days per well is used in this analysis.
- For counties that do not currently have a rig, a one-rig availability assumption is made.

Horizontal Rig Count

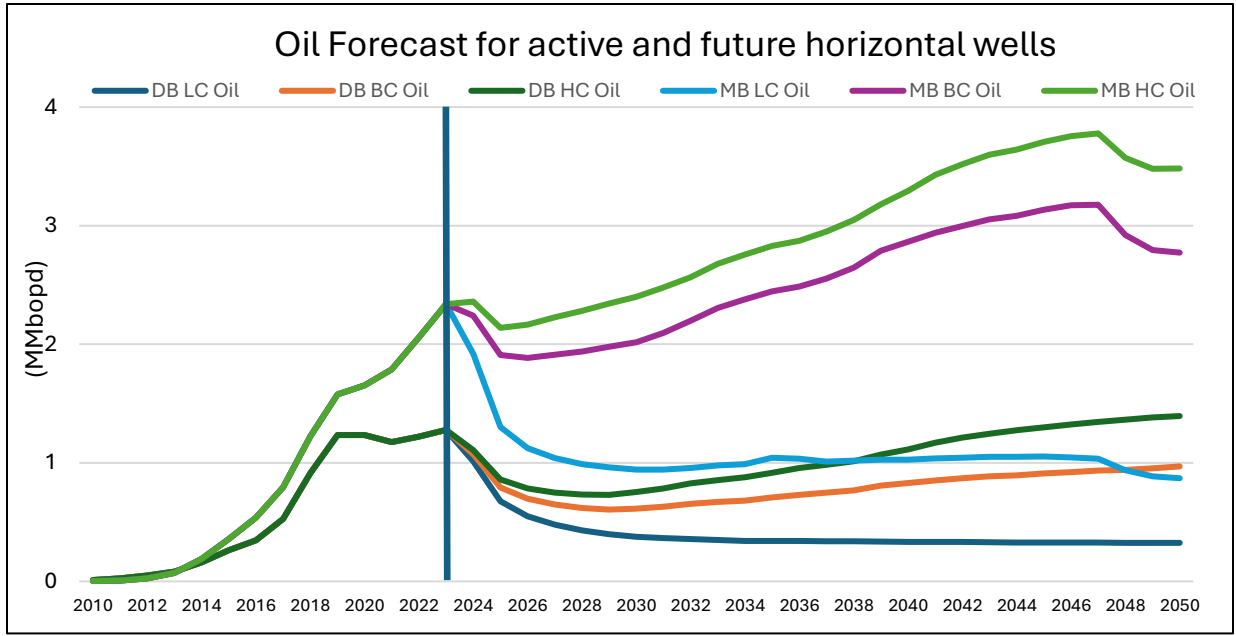




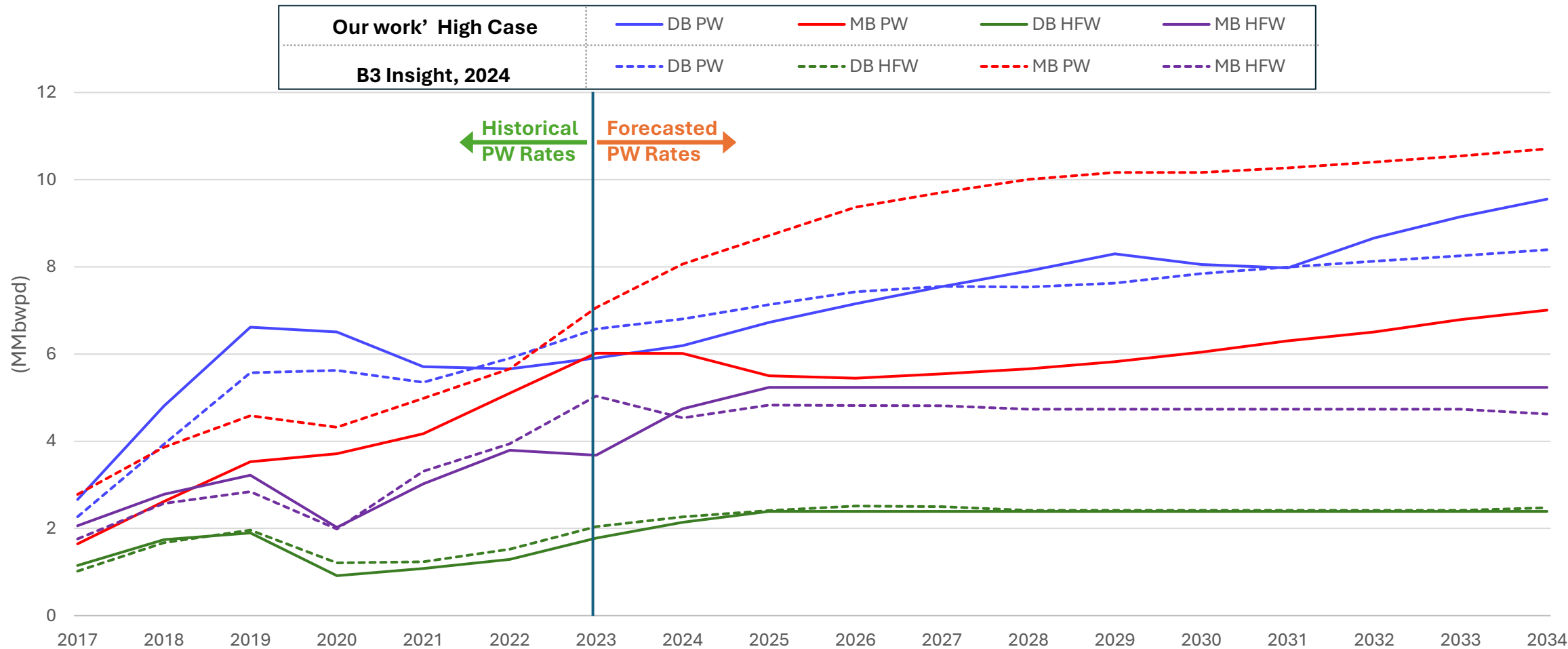
PW: produced water; **HFW:** hydraulic fracturing water demand

DB: Delaware Basin; **MB:** Midland Basin

LC: low case; **BC:** base case; **HC:** high case



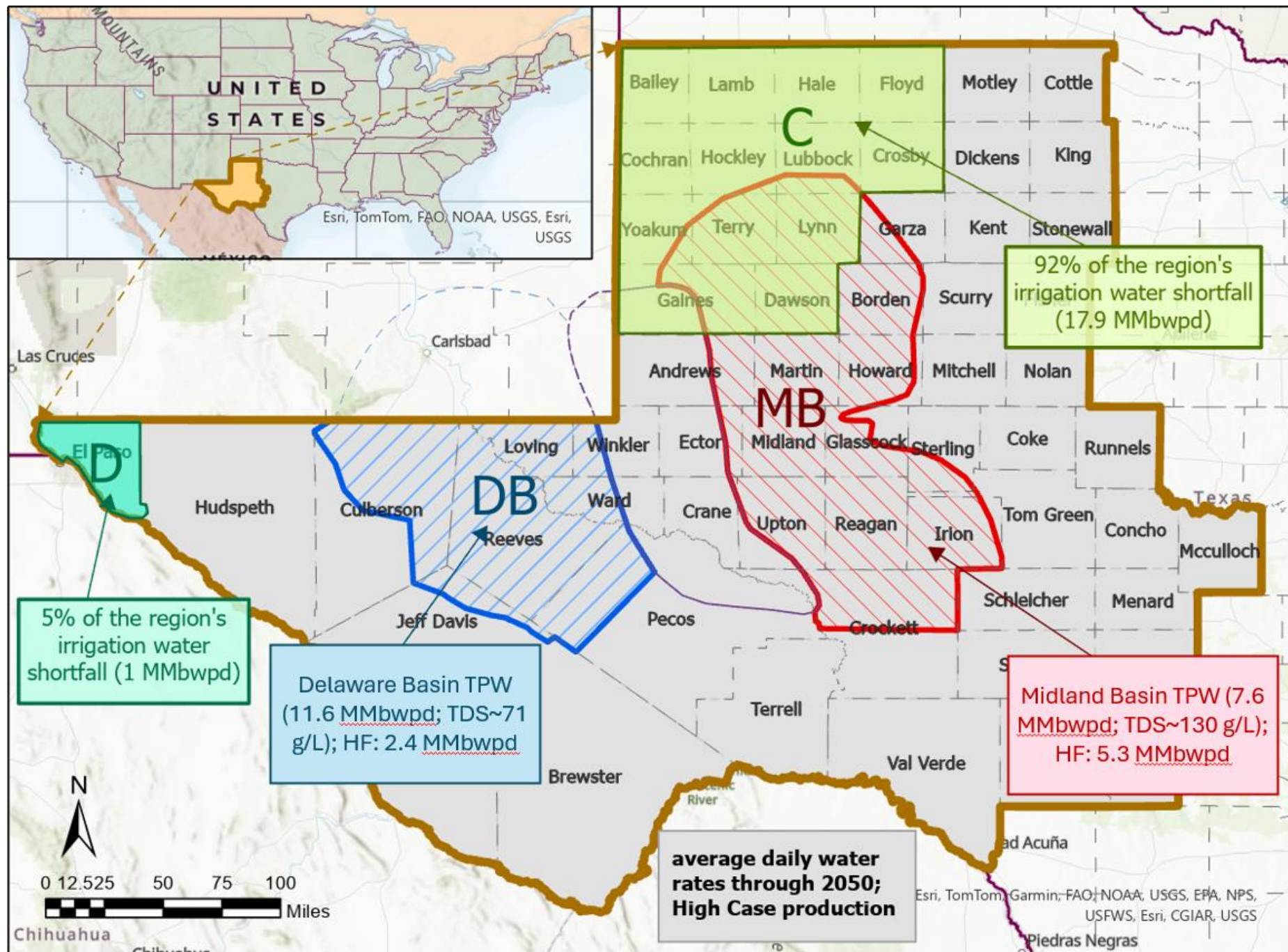
our work vs B3 Insight PW data



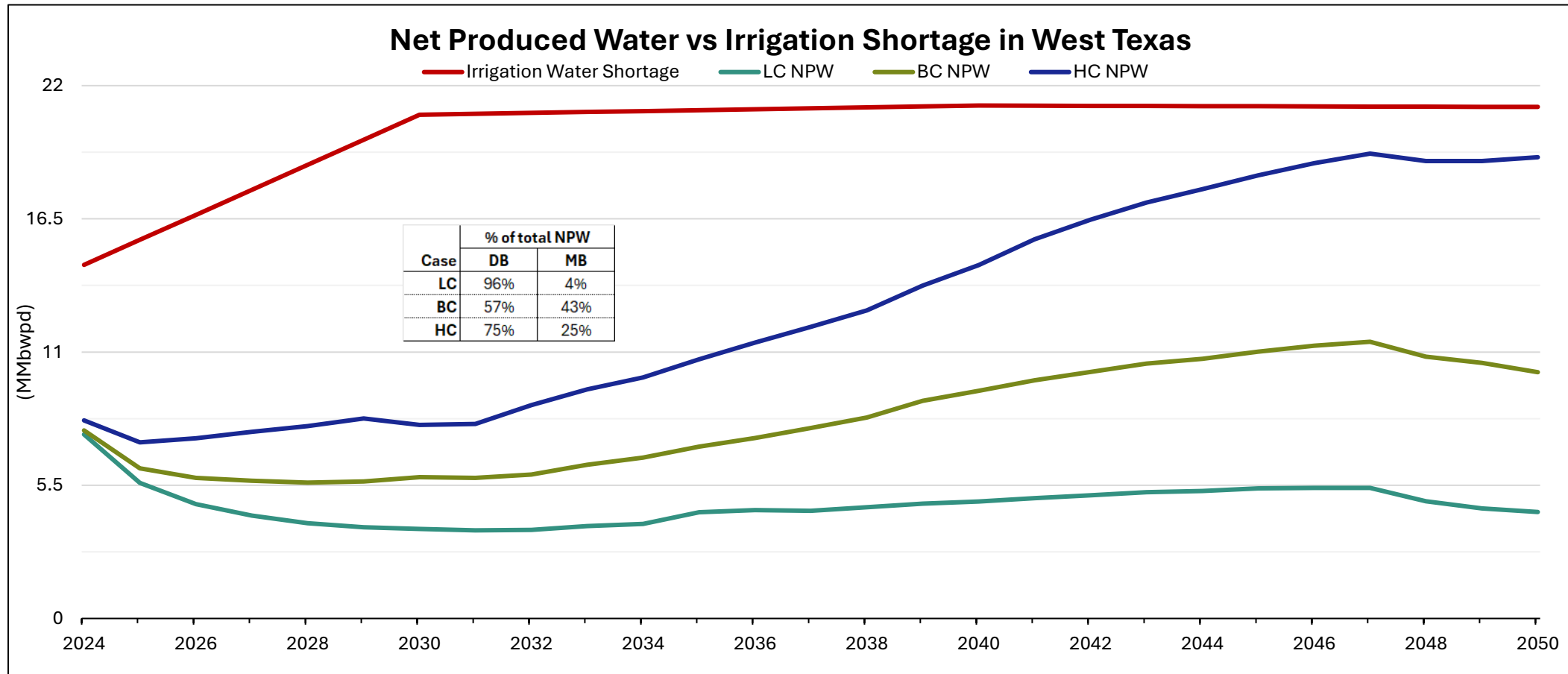
PW: produced water; HFW: hydraulic fracturing water demand

DB: Delaware Basin; MB: Midland Basin

BC: base case; HC: high case



Water Management: option 1



PW Recycling: 83% (estimated base on **B3 Insight** data): 58% in 2024; 91% in 2050

A 2022 TxPWC survey showed a 54% recycling percentage in HF

If net produced water is treated at 50% recovery, the effluent is disposed and **12% to 32%** of the irrigation water shortage is met

(Irrigation accounts for 87 % of the West Texas water shortage)

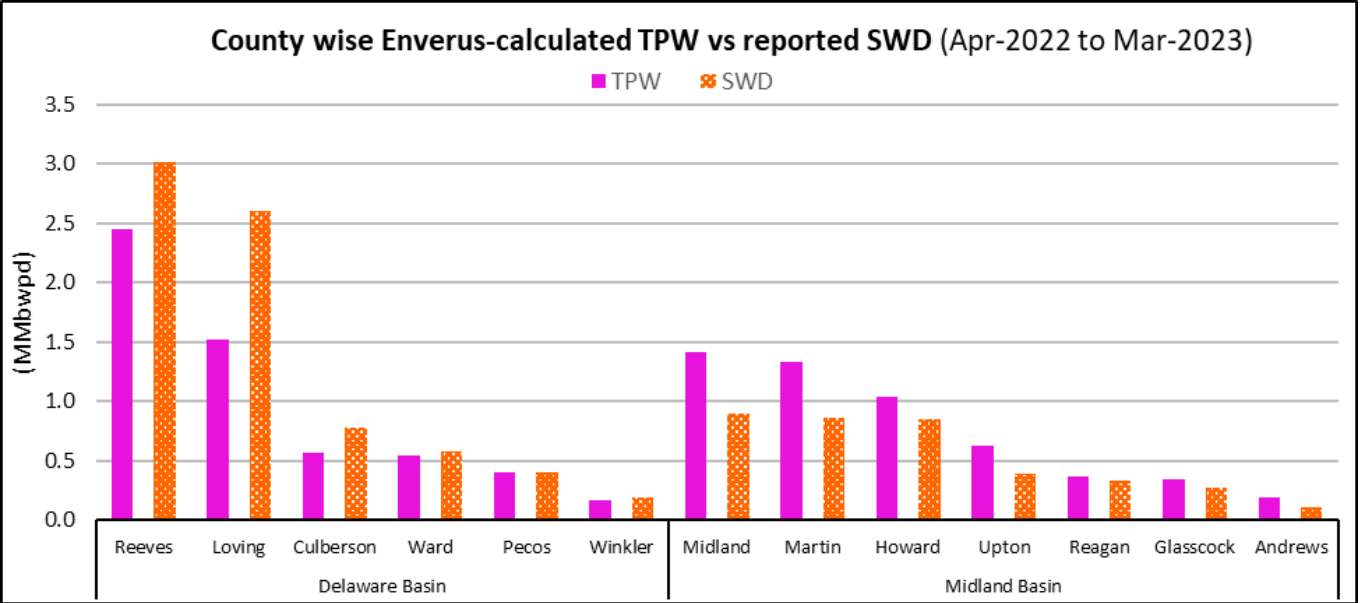
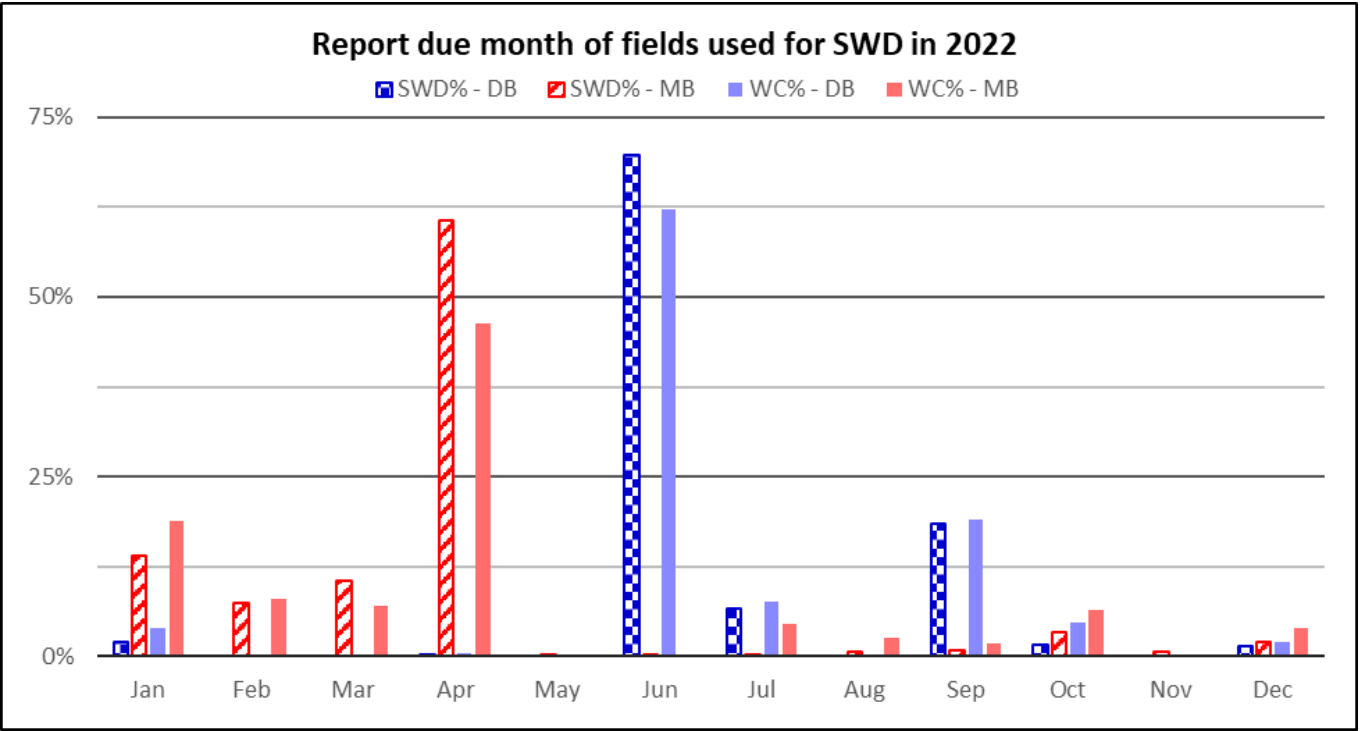
Challenge: Water-producing counties are substantially distant from areas with large irrigation water shortage

Thank You!

Questions?

ADDITIONAL SLIDES

SWD(details)

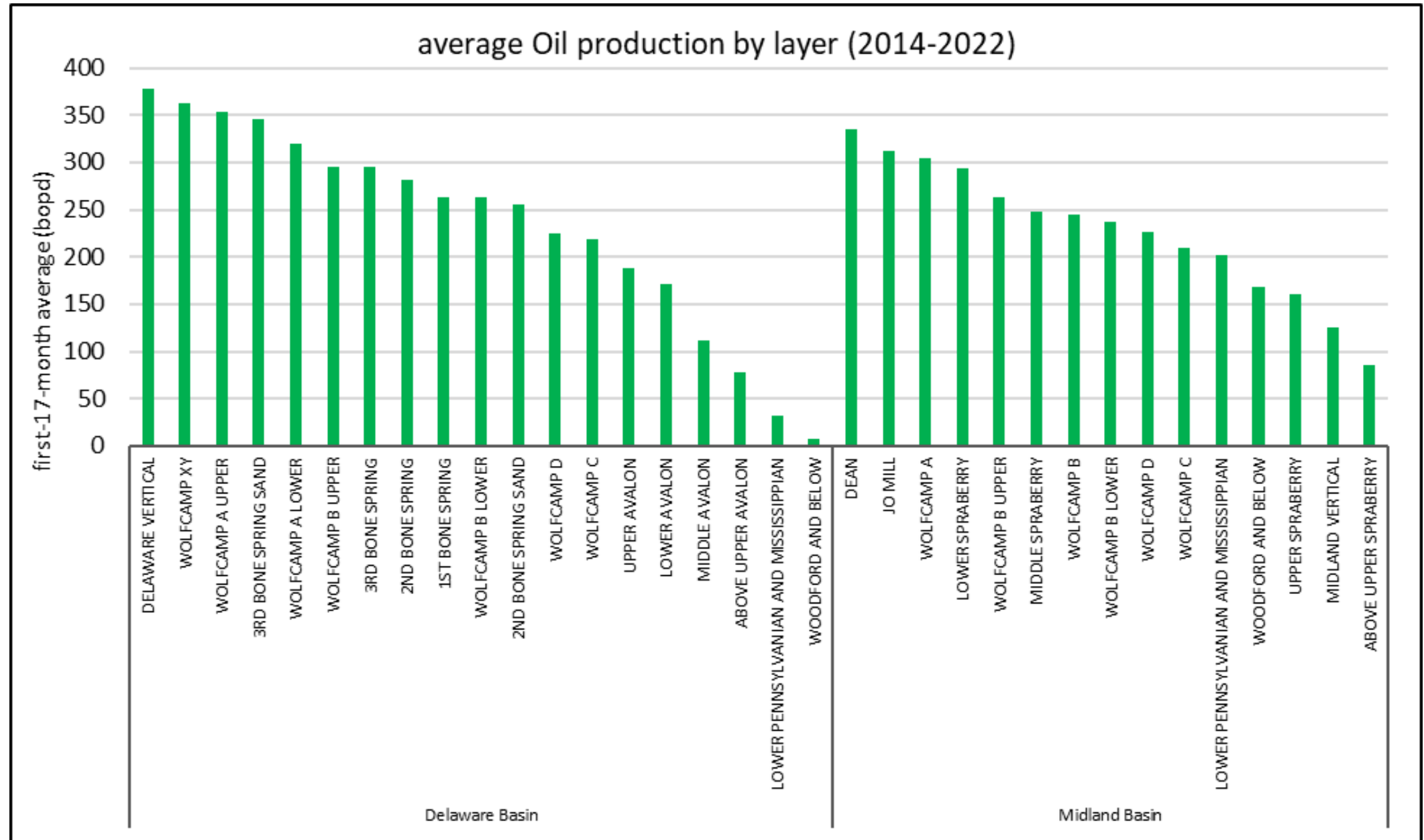


Production Forecast (details)

County	After 2017 Horizontal wells					
	b-Factors			Initial decline rate, Di (/yr)		
	Gas	oil	water	Gas	oil	water
Andrew	0.18	0.91	1.00	0.39	2.63	2.44
Borden	0.20	0.80	0.91	0.38	3.13	2.34
Crockett	0.80	1.23	1.13	0.23	7.89	8.58
Dawson	0.35	0.77	0.88	1.22	3.62	4.14
Ector	0.73	0.93	0.75	0.75	3.67	4.19
Gaines	0.73	0.25	0.53	1.25	0.15	0.83
Garza	0.73	0.25	0.53	1.25	0.15	0.83
Glasscock	0.80	0.85	0.80	0.36	3.84	3.93
Howard	0.50	0.90	0.90	0.25	3.77	1.82
Irion	0.00	0.94	0.91	0.14	6.30	5.88
Lynn	0.78	0.80	0.80	1.61	3.53	1.16
Marion	0.73	0.25	0.53	1.25	0.15	0.83
Martin	0.80	0.87	0.86	0.24	3.23	3.22
Midland	0.36	0.50	0.77	0.23	1.18	1.61
Mitchell	0.73	0.25	0.53	1.25	0.15	0.83
Randall	0.73	0.25	0.53	1.25	0.15	0.83
Reagan	0.00	0.97	0.88	0.18	3.92	4.41
Schleicher	0.36	0.50	0.77	0.23	1.18	1.61
Sterling	1.00	1.00	0.90	0.63	3.36	10.24
Sutton	0.36	0.50	0.77	0.23	1.18	1.61
Terry	0.80	0.90	0.47	0.35	0.36	0.30
Upton	0.37	0.60	0.90	0.25	2.89	0.41
Yoakum	0.50	1.00	0.20	0.12	4.06	3.44
Culberson	0.75	0.86	0.61	0.82	2.47	1.51
Jeff Davis	0.36	0.50	0.77	0.23	1.18	1.61
Loving	1.04	1.10	0.98	2.61	4.22	2.44
Mccoulloch	0.36	0.50	0.77	0.23	1.18	1.61
Pecos	0.80	0.78	0.87	0.46	1.81	1.74
Reeves	0.93	0.90	0.99	1.40	0.43	1.81
Ward	0.80	0.90	0.76	1.04	2.44	2.03
Winkler	0.80	0.40	0.50	0.38	0.70	1.03

Basin	County	Rig count			Max wells drilled per year, at a drilling rate of 18 days per well			Wells drilled by end of 2050		
		Low Case	Base Case	High Case	Low Case	Base Case	High Case	Low Case	Base Case	High Case
Midland Basin	Andrews	6	9	12	144	216	288	3,888	5,832	7,776
	Borden	1	1	2	24	24	48	648	648	1,296
	Crockett	1	1	1	24	24	24	648	648	648
	Dawson	2	3	4	48	72	96	1,296	1,944	2,592
	Ector	1	2	3	24	48	72	648	1,296	1,856
	Gaines	1	1	2	24	24	48	648	648	1,296
	Garza	1	1	3	24	24	72	298	608	917
	Glasscock	7	11	15	168	264	360	4,536	7,128	9,720
	Howard	16	25	34	384	600	816	10,368	16,200	22,032
	Irion	2	3	3	48	72	72	1,296	1,944	1,944
	Lynn	1	1	1	24	24	24	648	648	648
	Martin	23	35	43	552	840	1,032	14,904	22,680	27,864
	Midland	19	28	38	456	672	912	12,312	18,144	24,624
	Mitchell	1	1	1	24	24	24	161	242	323
	Reagan	3	6	7	72	144	168	1,944	3,888	4,536
	Schleicher	1	1	1	24	24	24	648	648	648
	Sterling	1	1	1	24	24	24	648	648	648
	Sutton	1	1	1	24	24	24	648	648	648
	Terry	1	1	1	24	24	24	372	648	648
	Upton	12	21	25	288	504	600	7,776	13,608	16,200
	Yoakum	2	3	4	48	72	96	3	7	11
Delaware Basin	Culberson	3	4	6	72	96	144	1,944	2,592	3,888
	Loving	16	25	34	384	600	816	10,368	16,200	22,032
	Pecos	5	8	11	120	192	264	3,240	5,184	7,128
	Reeves	15	22	30	360	528	720	9,720	14,256	19,440
	Ward	5	7	10	120	168	240	3,240	4,536	6,480
	Winkler	4	6	8	96	144	192	2,592	3,888	5,184
Total		151	228	301	3,624	5,472	7,224	95,443	145,361	191,027

Production Forecast (details)



Production Forecast (details)

