Horizontal Wells, Water Disposal and CCUS - The Changing Landscapes and Lessons Learned from Primary Production to Injection Projects

Presentation at the Whole Value Chain CCUS Conference Week

CSM – Golden, Colorado; September 22-26, 2025

Steve Melzer, Consulting Engineer

Melzer Consulting

Midland, Texas

Horizontal Wells, Water Disposal and CCUS
The Changing Landscapes and Lessons Learned
from Primary Production to Injection Projects

I. A Bit of History of Horizontal Wells: Changing the Oil & Gas Landscape in Recovery: from Primary to Large Volume Injection Projects

II. Timeline of Horizontal Well Emergence and Imminent 'Double Peak': U.S. Oil & Gas Recovery Statistics

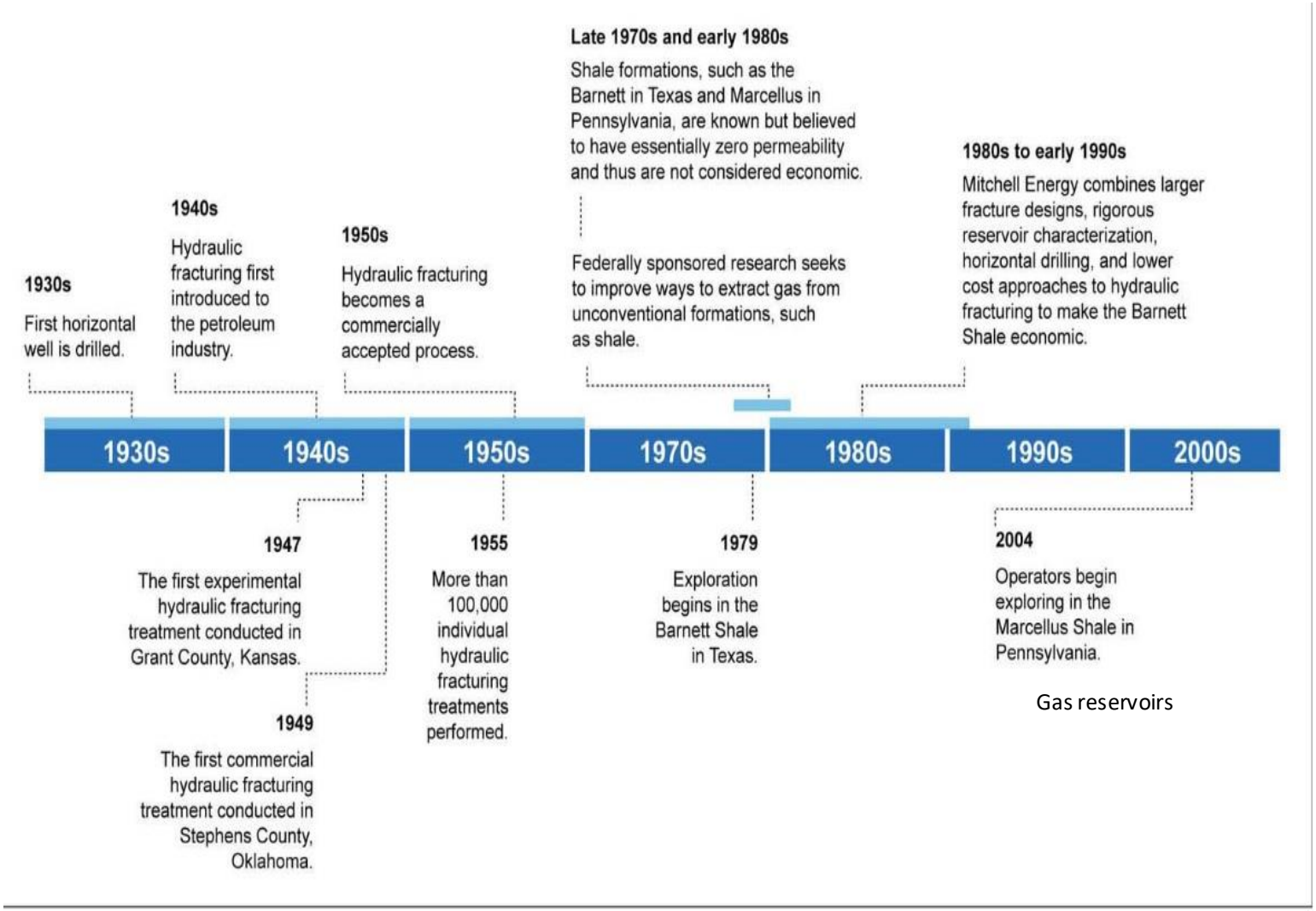
III. The Latest in Excitement

IV. Time for Application in IOR & CCUS?
   - A. Mature Oilfields
   - B. Residual Oil Zones (ROZs)
     1. Brownfields
     2. Greenfields

V. Challenges – CCUS Engineering Experience, Water Disposal, Injection Permitting, Old Wellbore Blowouts, Two Different Worlds: Hard Rocks vs. Soft Sediments

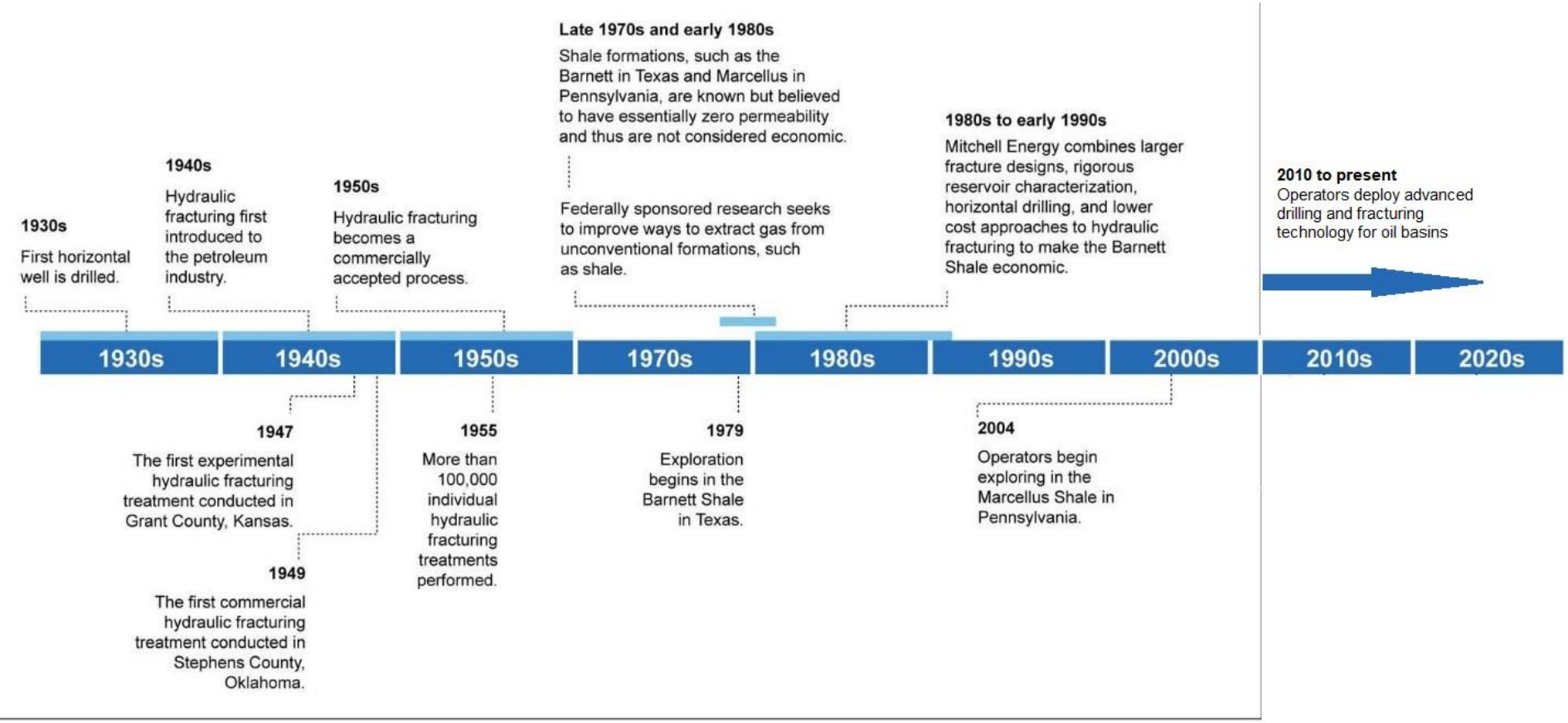
VI. Thoughts on Where the Young Talent Needs to Take the World

The Drilling and Hydrofracturing Timeline



Source: GAO.

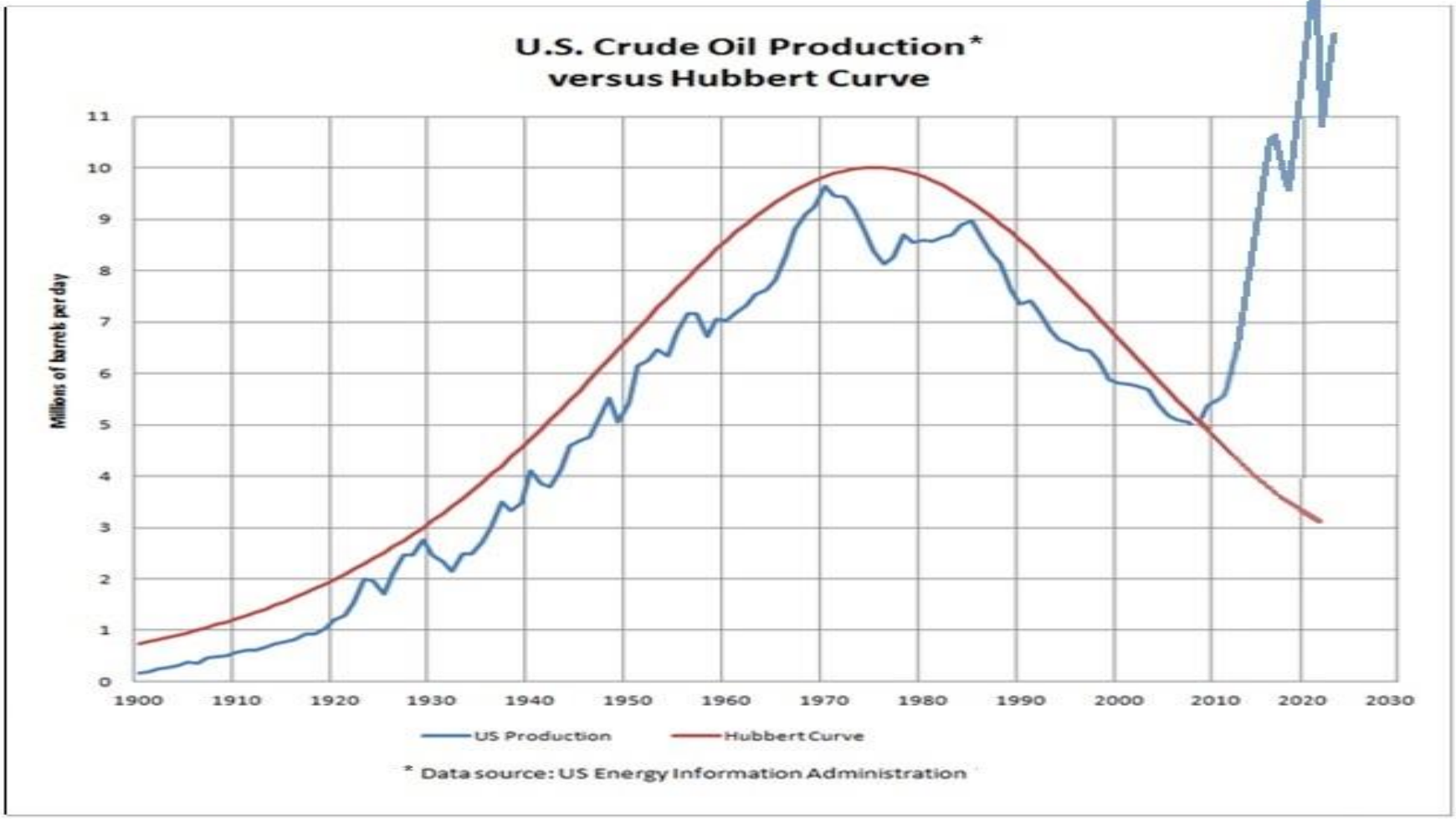
The Drilling and Hydrofracturing Timeline & Horizontal Well 'Revolution'



Source: GAO.

Our Old 'Friend' – the U.S. Version of 'Hubbert's Peak'

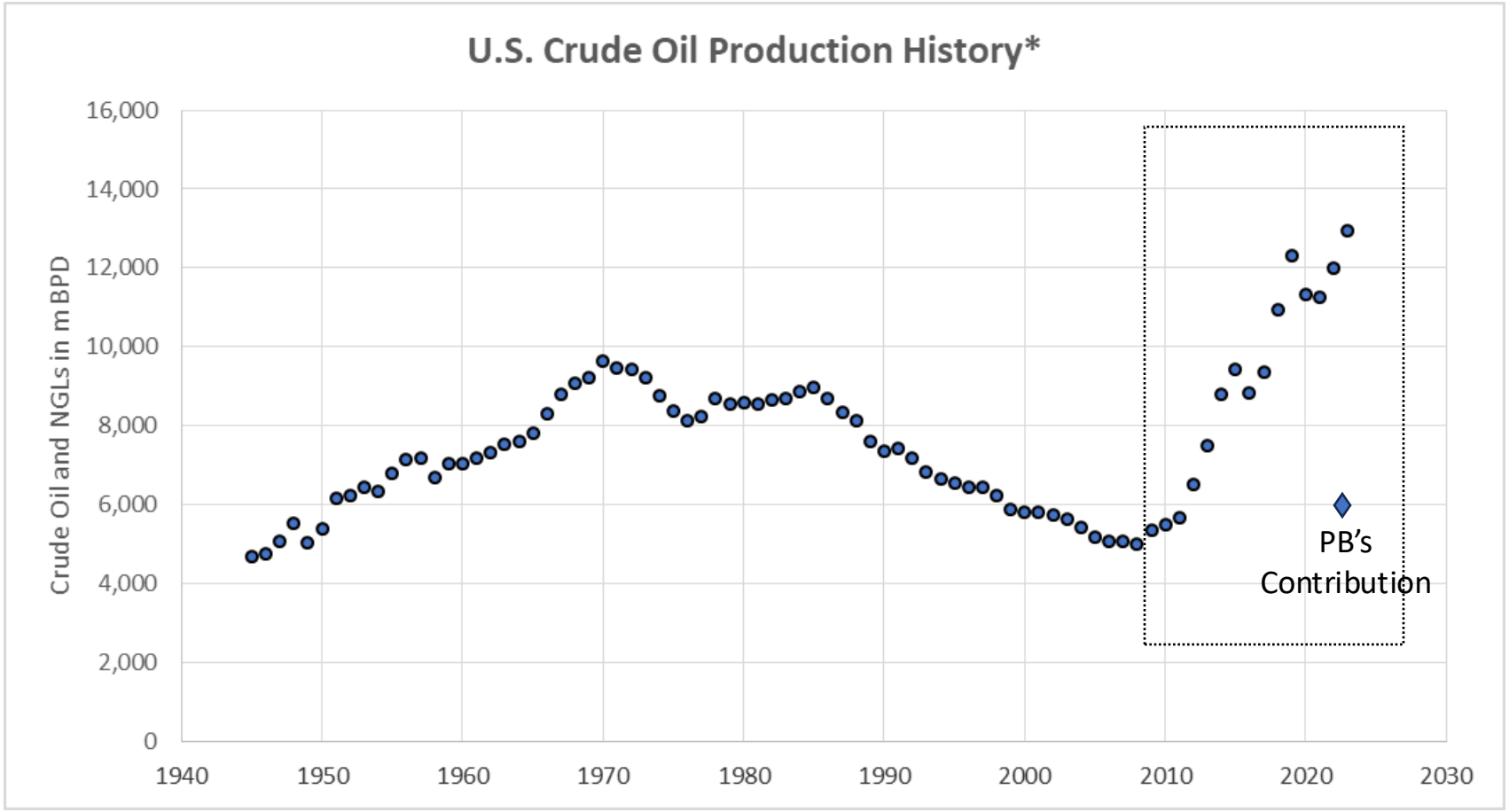
Woops……Technology Happened



* Data source: U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=M_EPL2_FPF_NUS_MBBLD&f=A

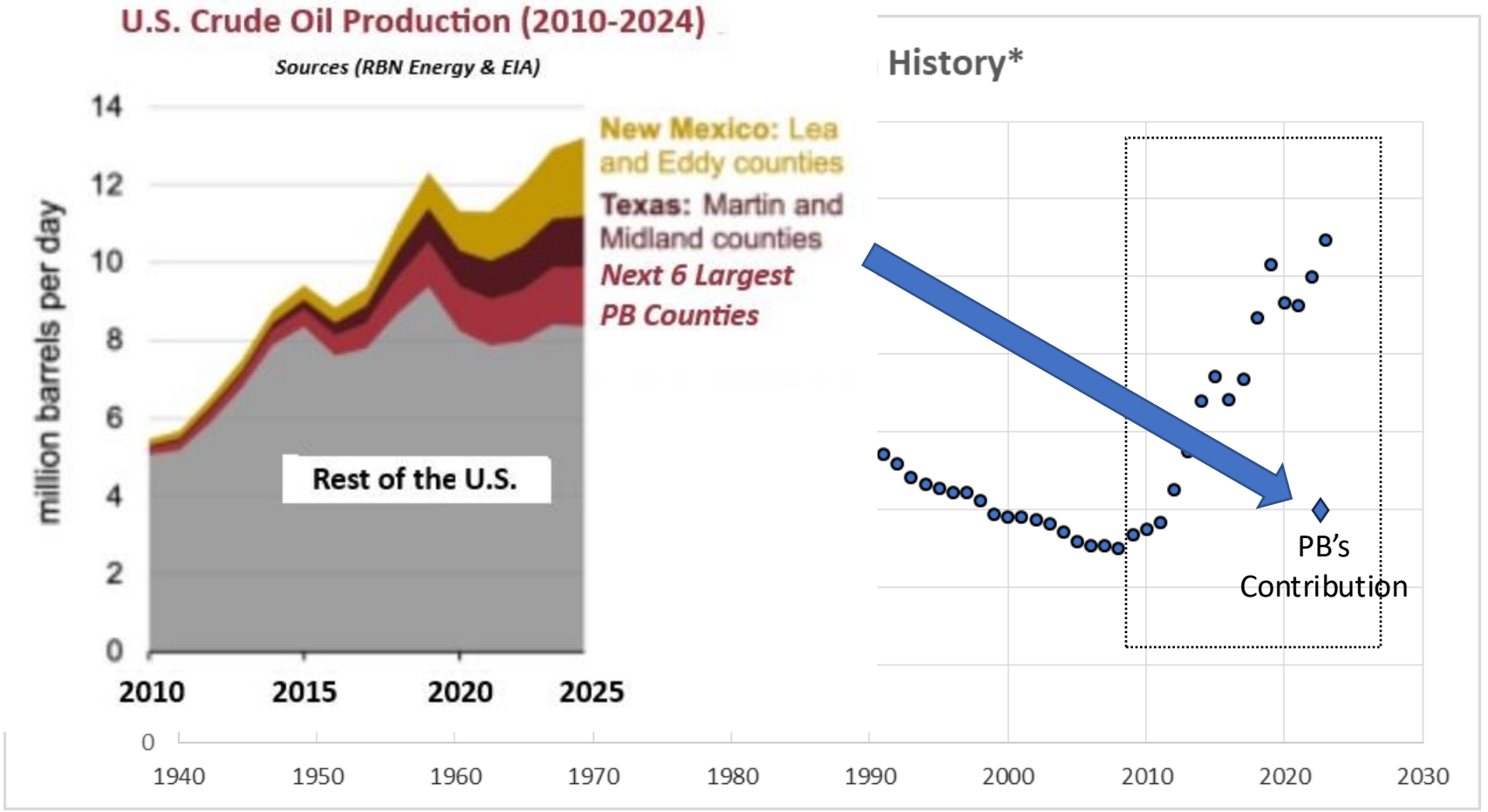
Melzer COnsulting

‘Double Peaking’ - (Hubbert’s Update)



* Data source: U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=M_EPL2_FPF_NUS_MBBLD&f=A

‘Double Peaking’ - (Hubbert’s Update)

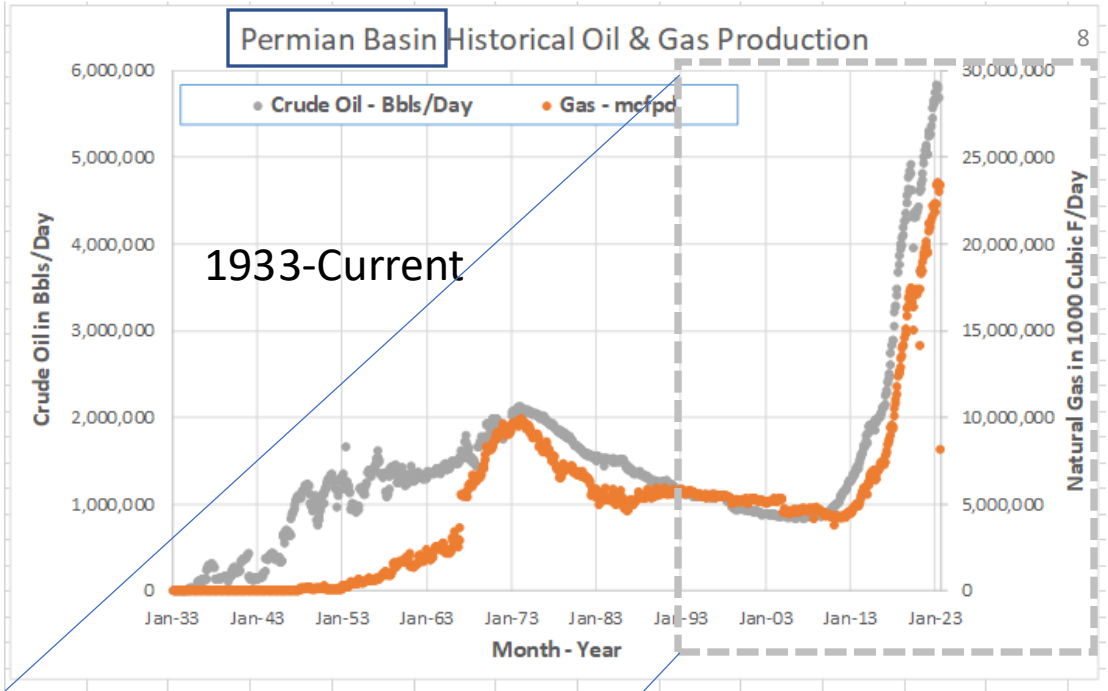


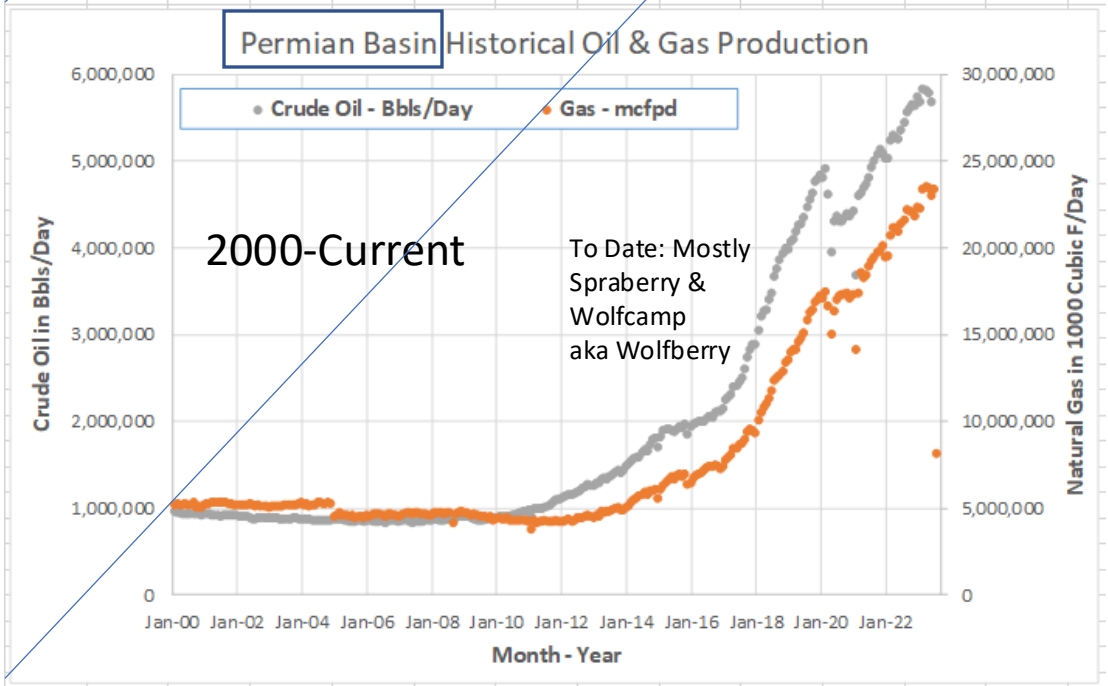
* Data source: U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=M_EPL2_FPF_NUS_MBBLD&f=A

The PB Example of the Horizontal Well 'Revolution'

2010 to Present

- Drilling and Completions Getting Less Expensive
- Exposing More Formation-Ft
- Laterals Getting Longer

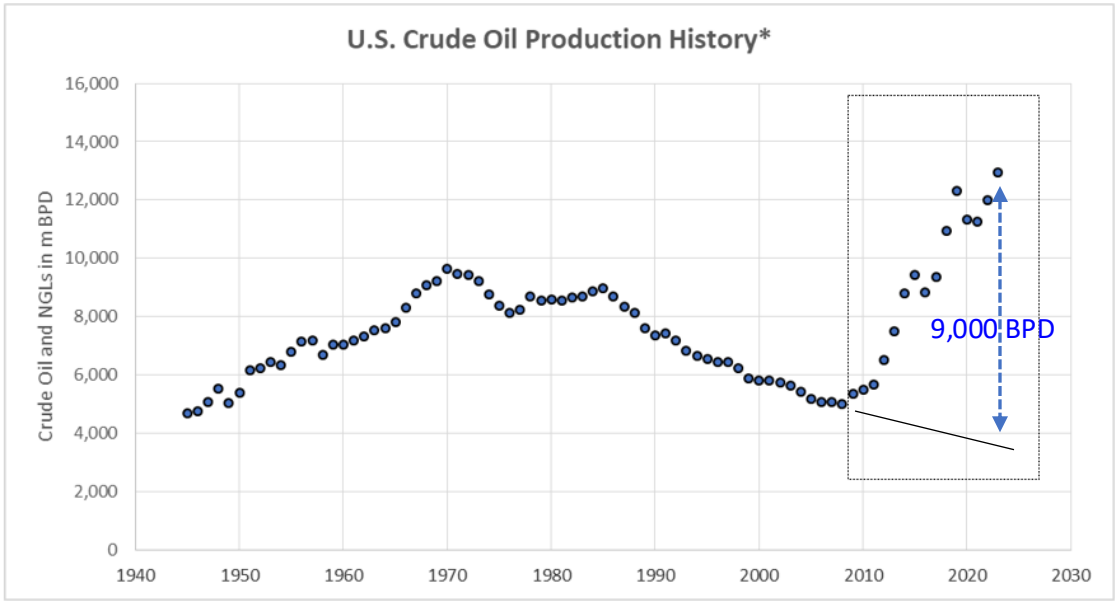




Melzer Consulting

A Look at the Significance of U.S. Horizontals on the World's Oil Supply

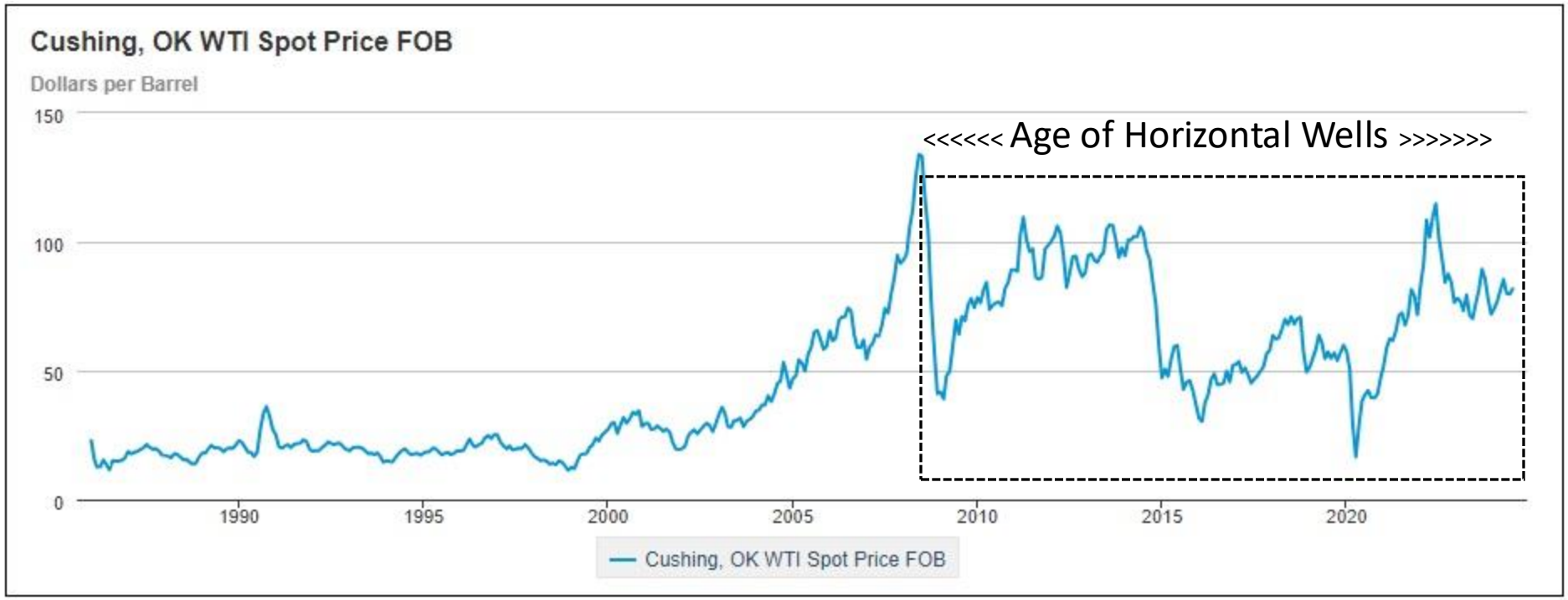
- Current Total World Oil Production is 102 mmbopd*
- US Shale Crude Oil Production of 8.3 mmbopd* is 8% of the World production!!!



* *Source: EIA (2024); https://www.eia.gov/tools/faqs/faq.php?id=847&t=6*

Let's Quickly Look at Pricing

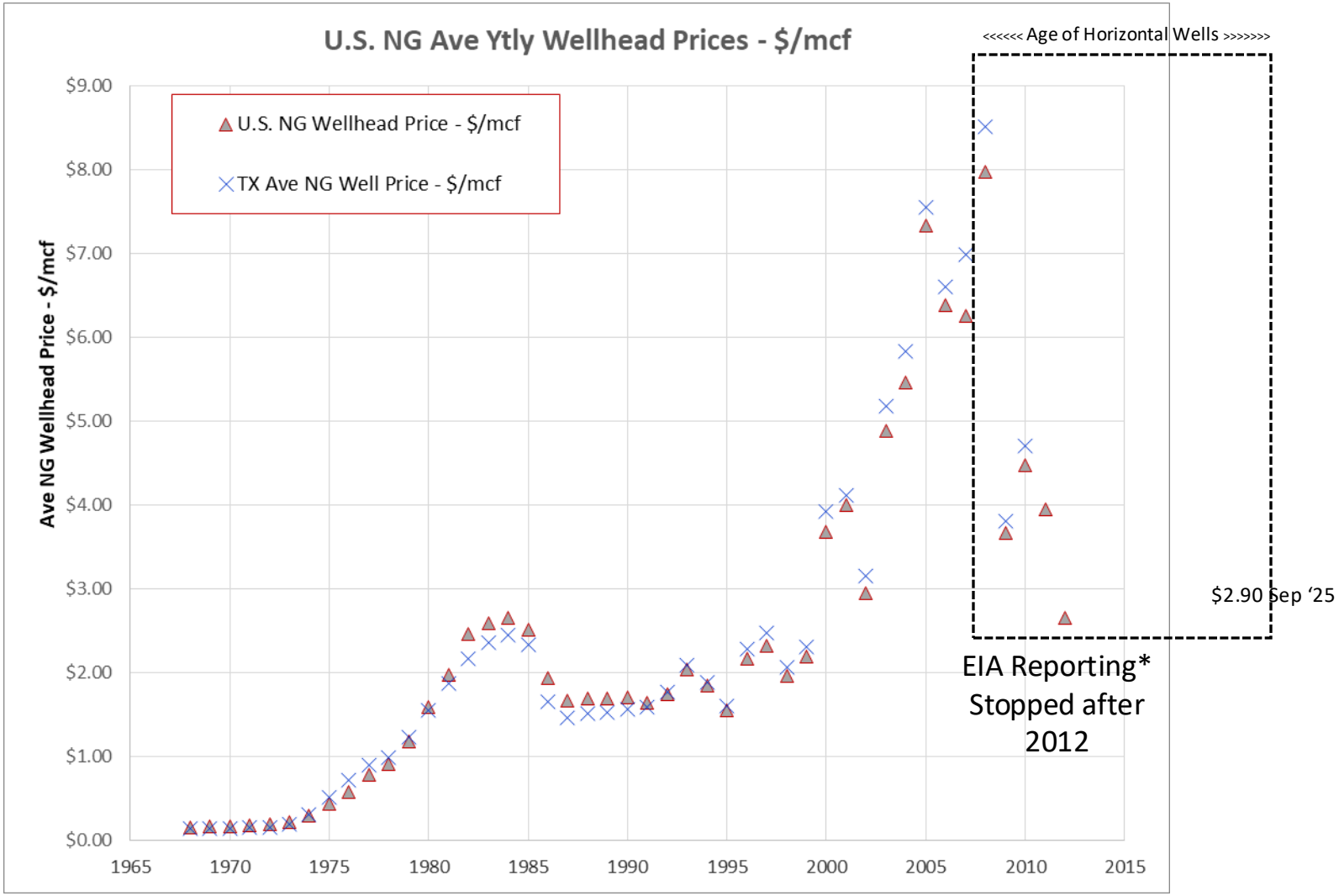
Oil Pricing*



* Source: US EIA: (https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rwtc&f=m)

What would be the price of oil w/o U.S. horizontal well's contribution?

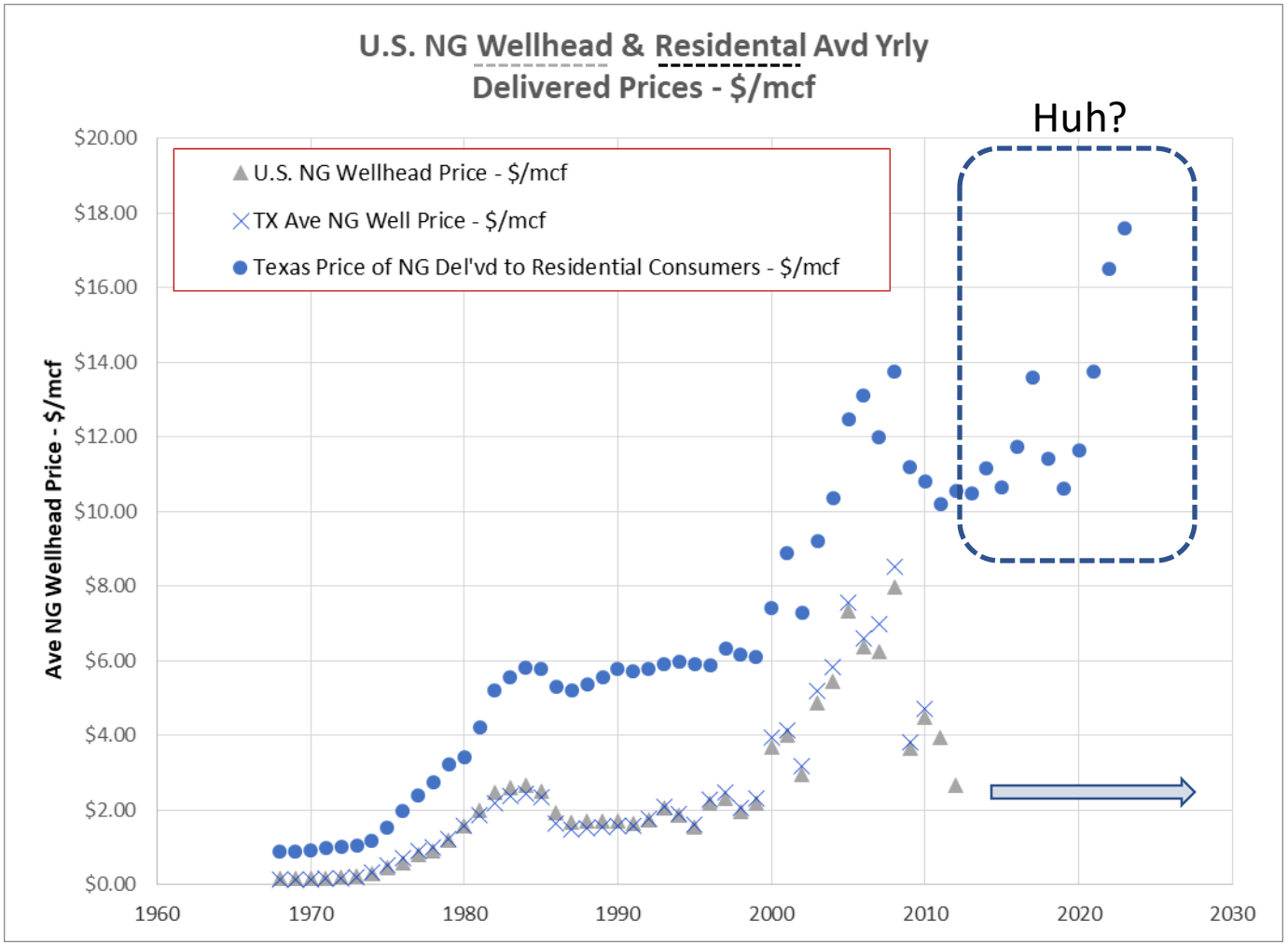
And Look at What Have we Done with Wellhead Gas Pricing!!



** Source: https://www.eia.gov/dnav/ng/hist/n9190us3a.htm*

Melzer COnsulting

An interesting Sidebar:
but……
What Has Happened with Residential Delivered Gas Pricing??



The Latest Excitement in Horizontal Wells

New *Excitement #1*: Here's An Example of the New (Primary Recovery) Discoveries

C6 SATURDAY, AUGUST 17, 2024 MIDLAND REPORTER-TELEGRAM | MRT.COM

SM Energy details Woodford-Barnett well results

By Mella McEwen
OIL EDITOR

After keeping mum on activity in its Sweetie Peck area, SM Energy is spilling the beans on its work on the development at the intersection of Midland, Upton and Crane counties.

During its second quarter earnings call, SM President and Chief Executive Officer Herb Vogel told analysts the company has confirmed bringing online two Woodford-Barnett wells during the quarter. One, a 10,200-foot lateral test, had a 30-day peak initial potential of 1,622 barrels of oil equivalent per day while the second, a 5,900-foot lateral, had a 30-day initial potential peak of 830 BOE per day.

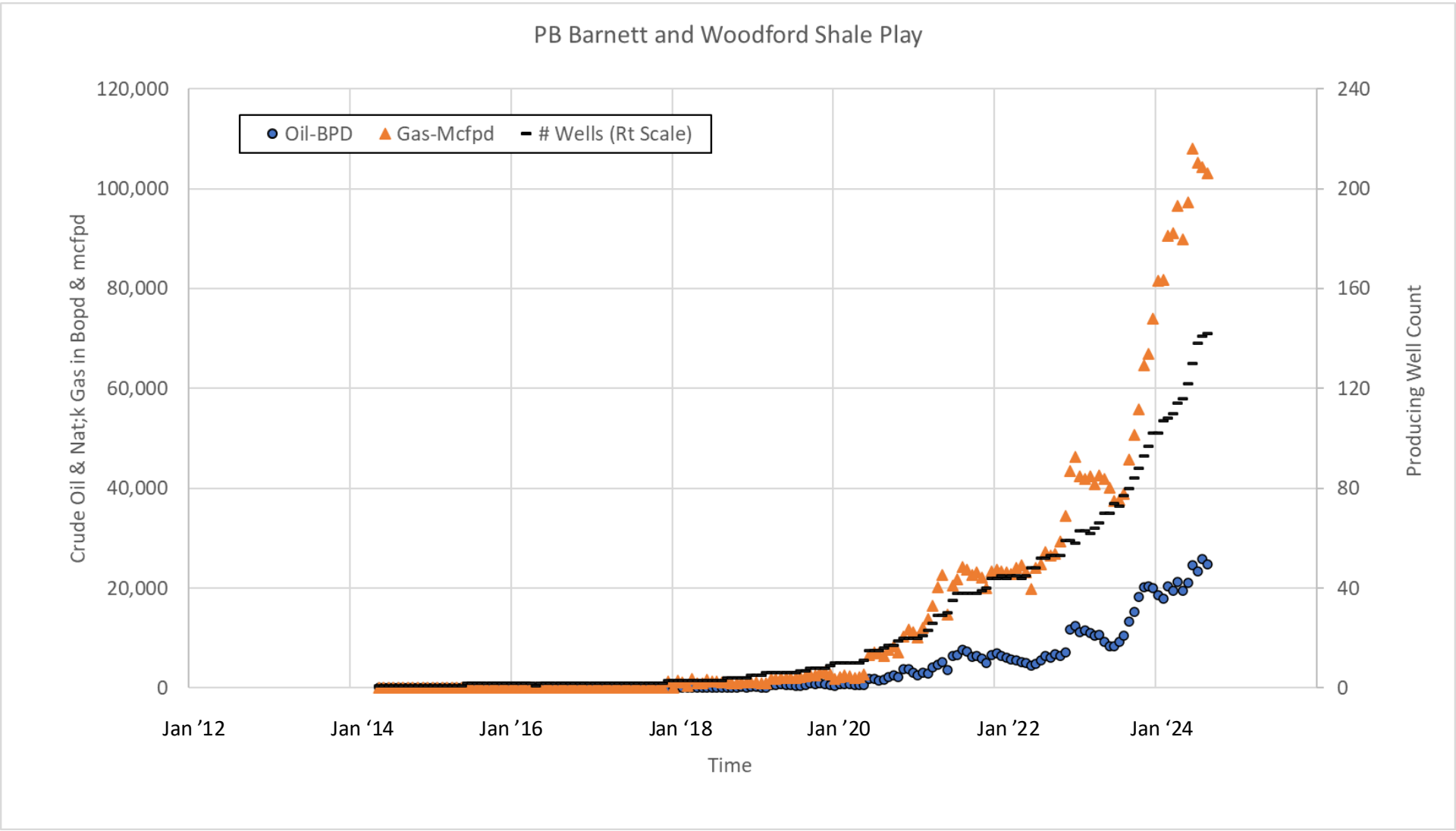
"We are very pleased with early results and the potential to add more than 20,000 prospective net acres in this deeper formation," Vogel said during the call. He said the two wells, together with offset operator wells, indicate more than 20,000 net acres at Sweetie Peck that are prospective for Woodford-Barnett development — inclusive of previously announced acreage additions to the west.

"We have been tight-lipped about our activity in the greater Sweetie Peck area for some time as we added acreage," he told analysts, but with the production data now public, he said the company was pleased to report the data. Initial results compare favorably to peers in the area, he said.

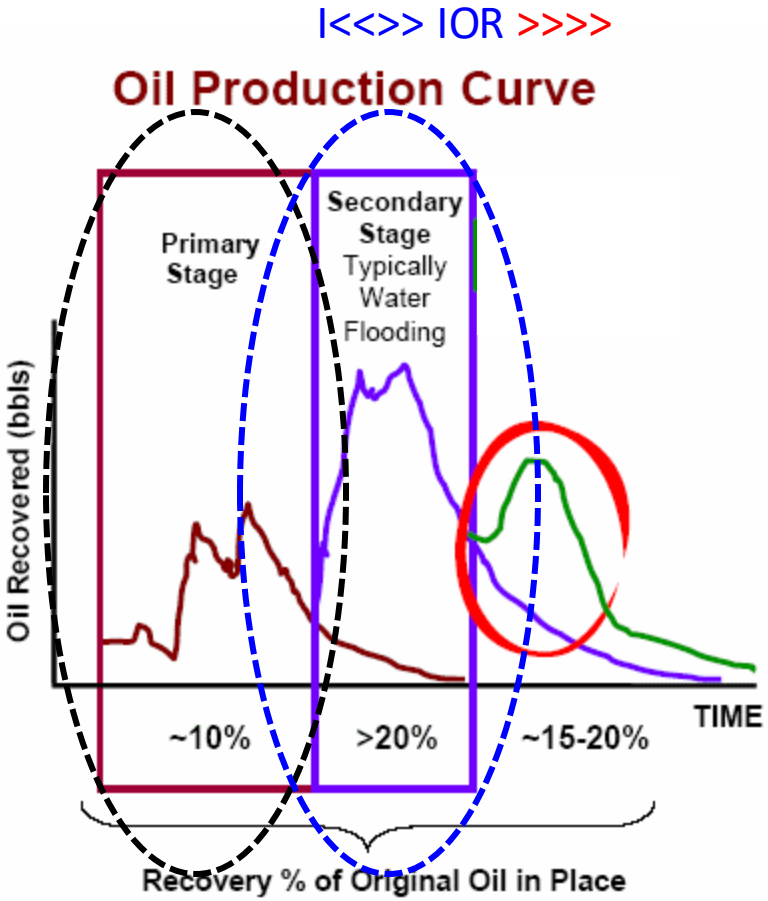
In the Midland Basin, SM plans 72 wells drilled and 71 completions. The expected average lateral length is about 11,760 feet, including 32 wells with 15,000-foot average lateral length. SM plans to run four rigs and two completion crews.

…And Yet Another Shale Formation Play

Excitement #1 (Cont'd)



In the Unconventionals, at lease so far… it's all about Primary Recovery (of course)



Now Let's Move to "Post Primary"Production

Some Important Work has been Done for IOR in the Unconventionals

- Almost all is Confidential
  - EOG's Enriched Natural Gas Injection work in the Eagle Ford
  - Some also (unreported) in the Permian Wolfcamp (Oxy for one)
  - Others?
- But….Fast rates of investment return of new drills (<2 or 3 years) have stymied more work on historically slower IOR returns

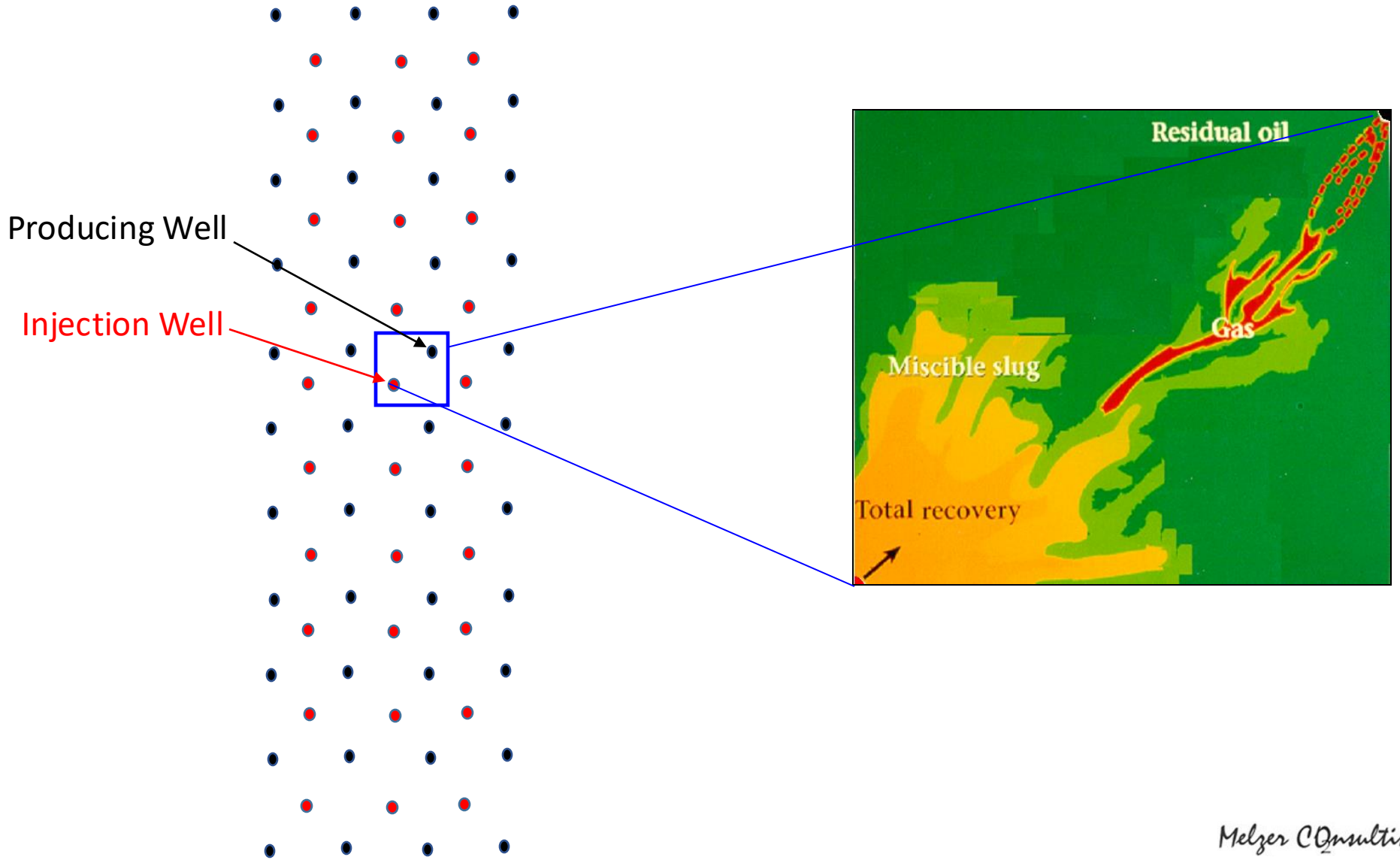
Let's Move Now to More Conventional Reservoirs

Specifically…
Mature Water Floods and Residual Oil Zones

Computer Modeling Challenges

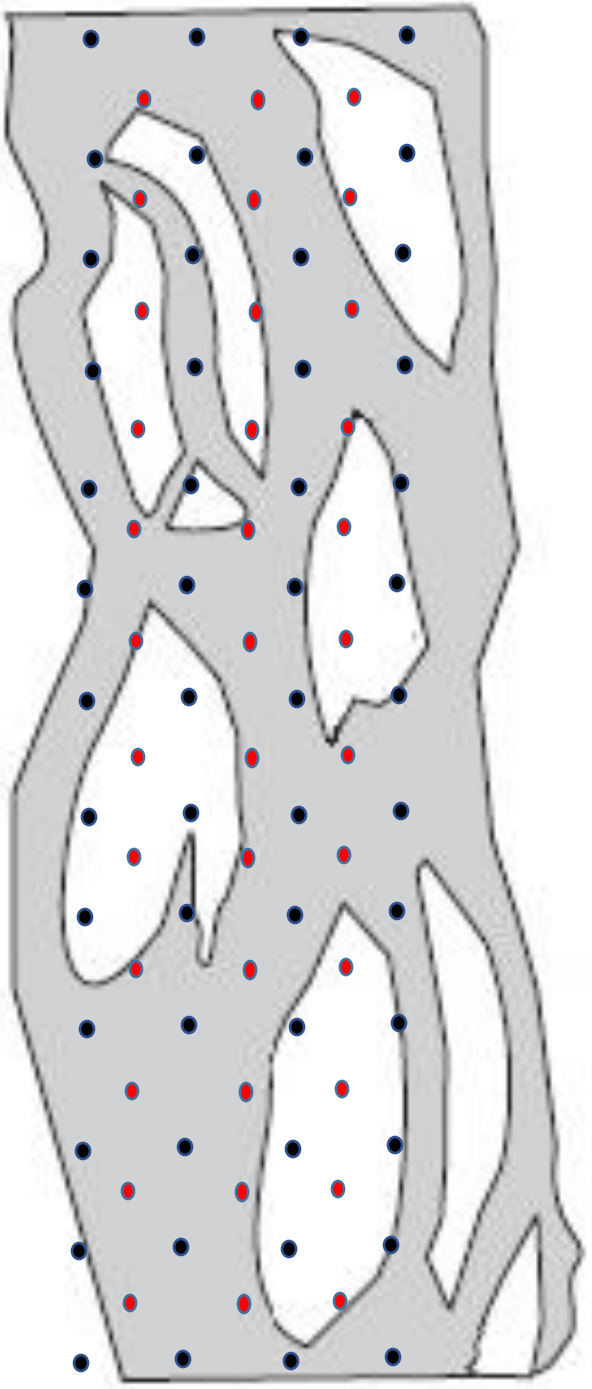
RESERVOIR SWEEP CONCEPT

Bird's Eye View (Areally Speaking)



Example of a "Typical" Reservoir (Just One of the Reservoir Depth Intervals)

Superimposed Producing (●) and Injection Wells (●)



Then Add Several More Depth Intervals In a Basin Unconventional Reservoir System

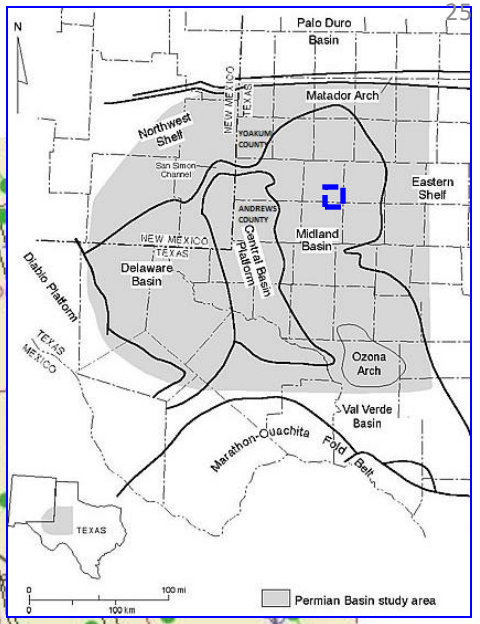
And then….you have a "hybrid" Unconventional/Conventional Reservoir Reservoir System

Excitement #2: A New Flooding Concept Coming in this Amazing Age of Horizontal Wells

- 3 & 3.5 Mile Laterals between existing and plugged wells
- Estimated D&C Cost of $8.0-8.5mm
- Drilled & Completed in 14 days
- 200’ spaced stages – limited entry hydrofracs
- Concept: Replacing 20 or more vertical in-fill wells at $600-700K a piece?

Mature Waterflood – New Horizontal Wells

Excitement #2



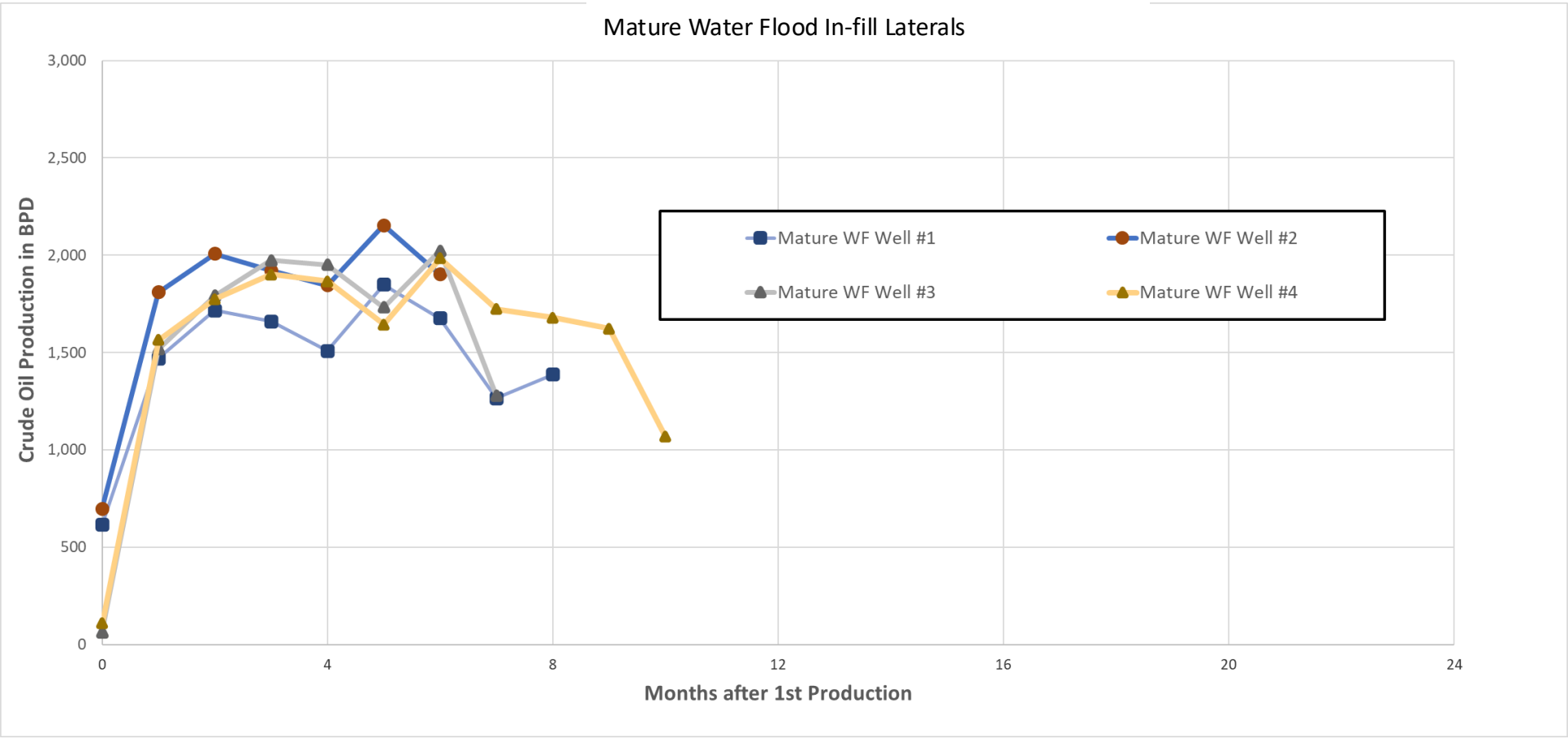
Water Flood Unit Boundary

Dawson County, TX
Martin County TX

Borden Co, TX

Howard Co., TX

‘Brownfield’ Lateral Wells in an Old Waterflood



Cumulative Oil at 8 Months = 390-430 mmBbls
& @ $65/Bbl, 75% NRI = 19-21 mm$

Melzer Consulting

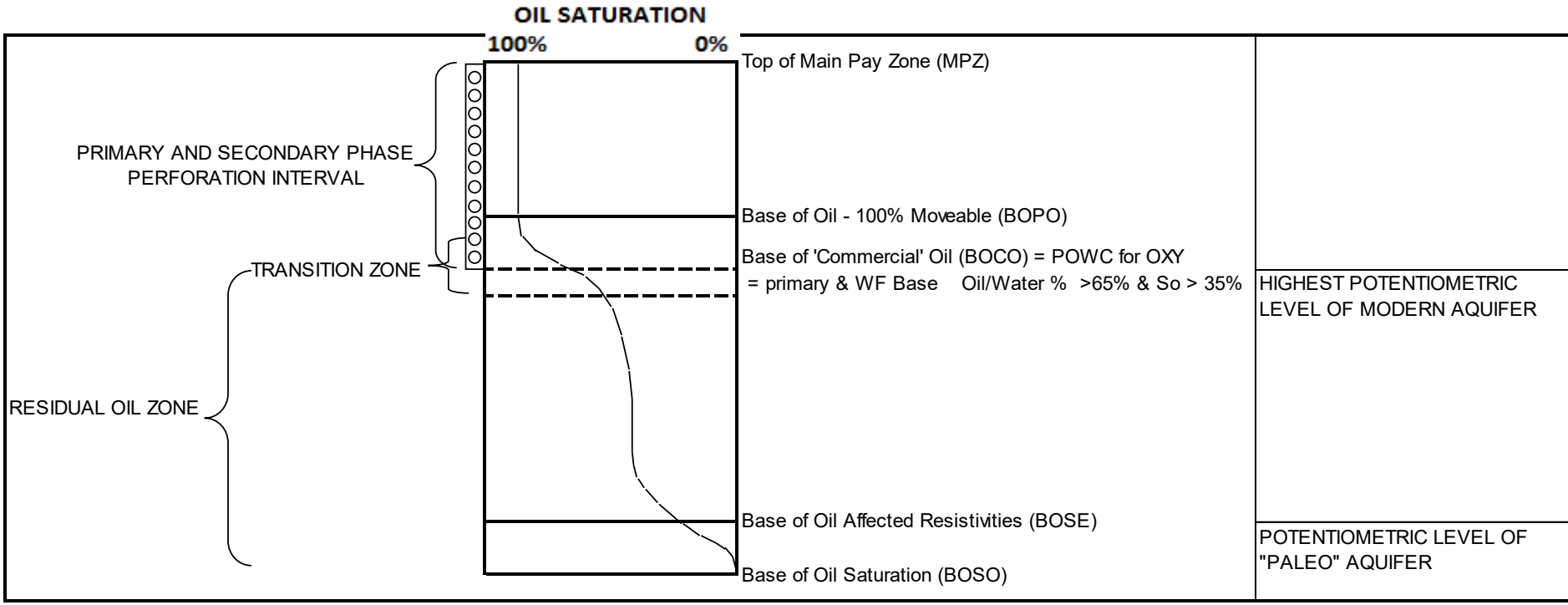
On to Another of My Favorite Subjects

CO_2 EOR and Residual Oil Zones

Excitements #3 & 4

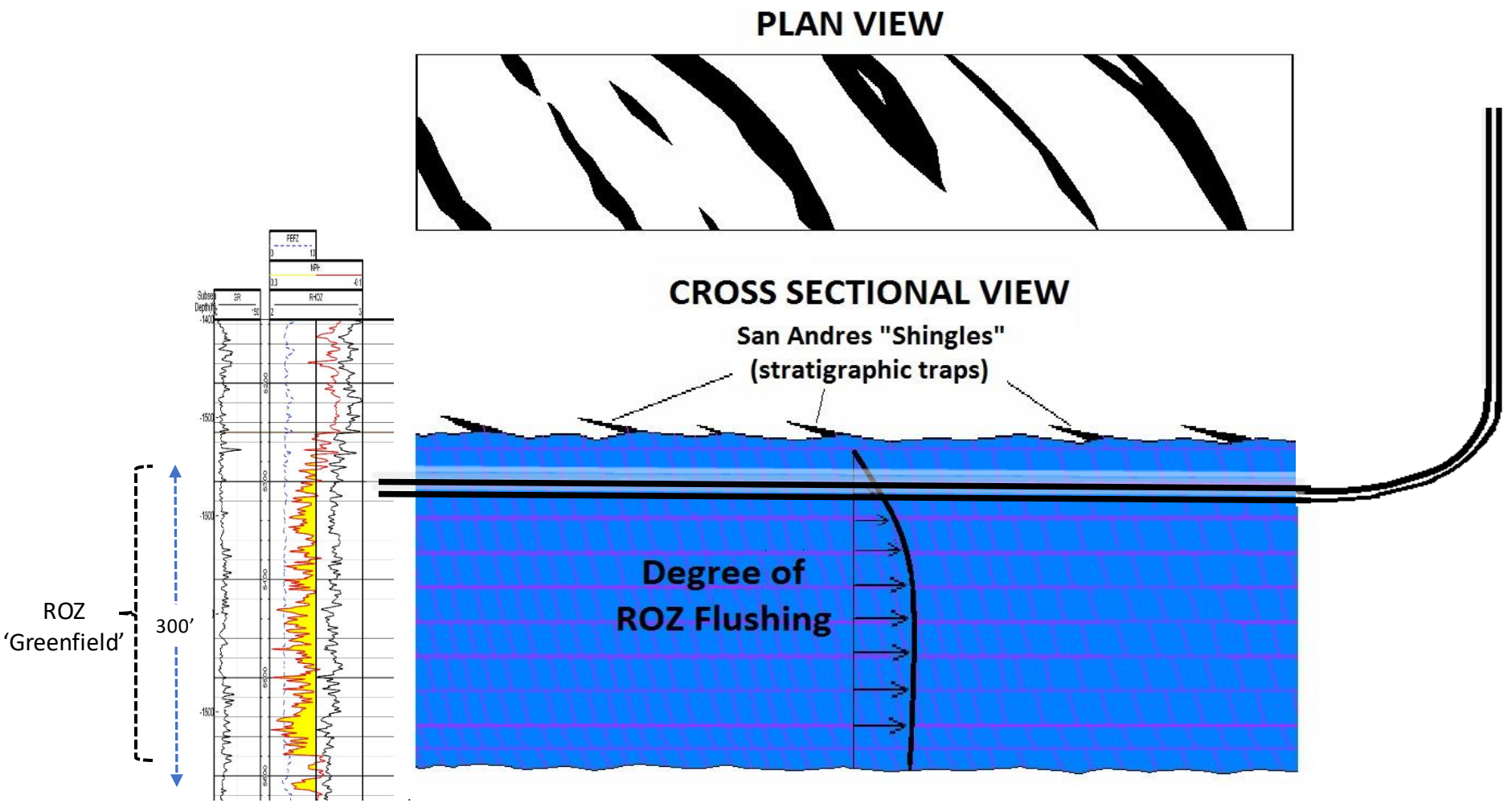
ROZ Definition

That Portion of a Reservoir Below the Oil/Water Contact Where Residual Oil Resides but the Mobile Phase is Water



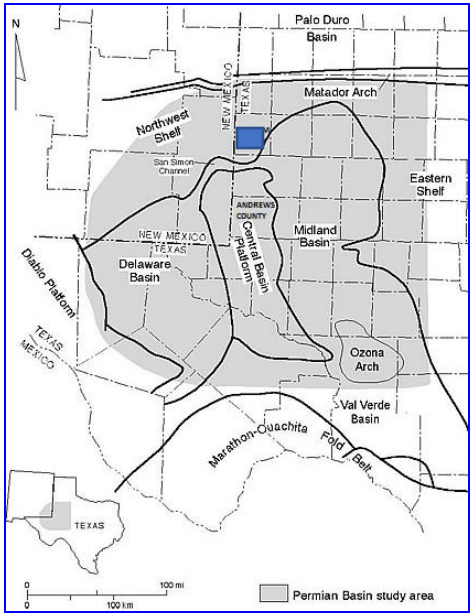
Example: The Horizontal Well ROZ Play

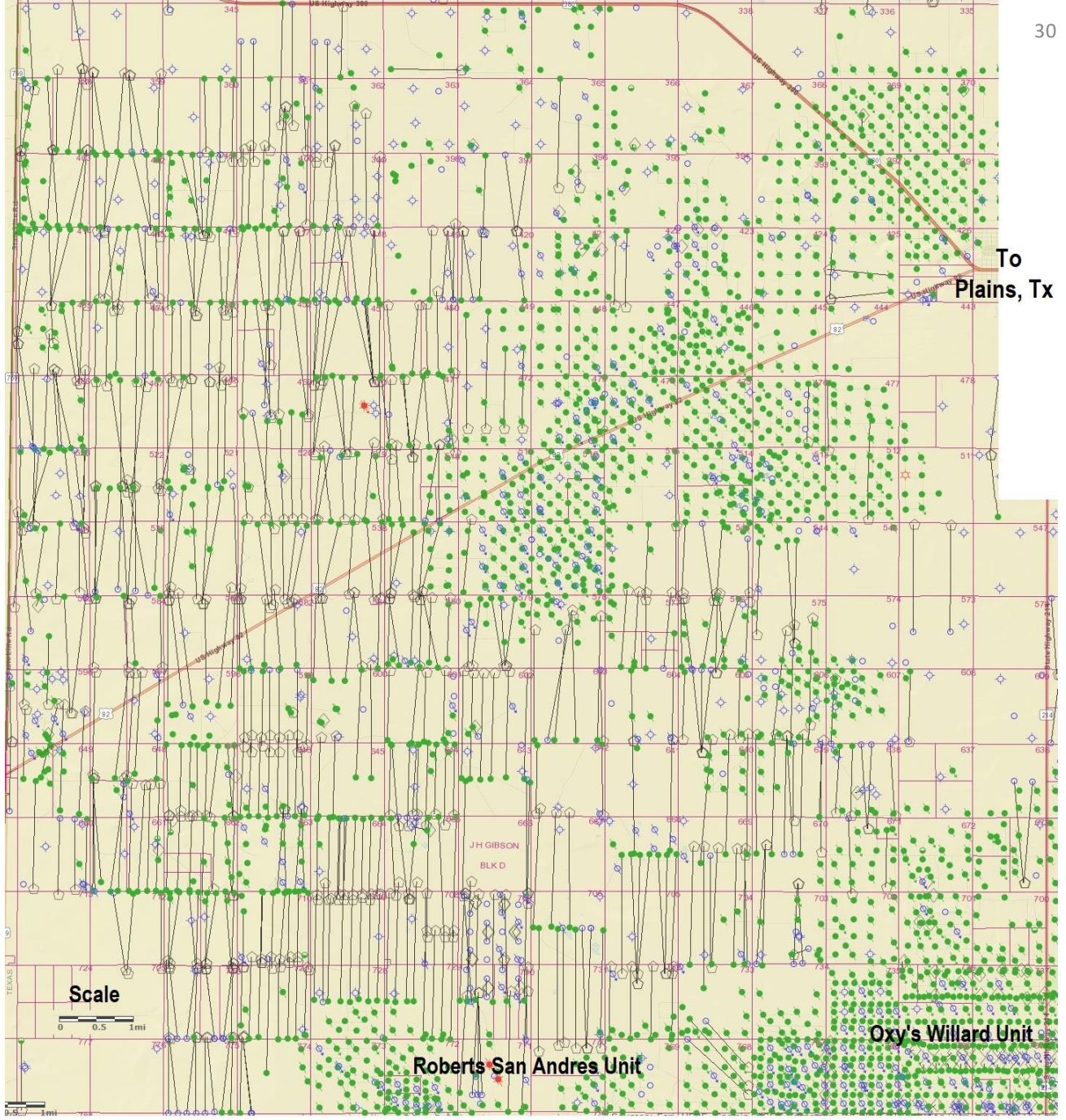
Excitement #3



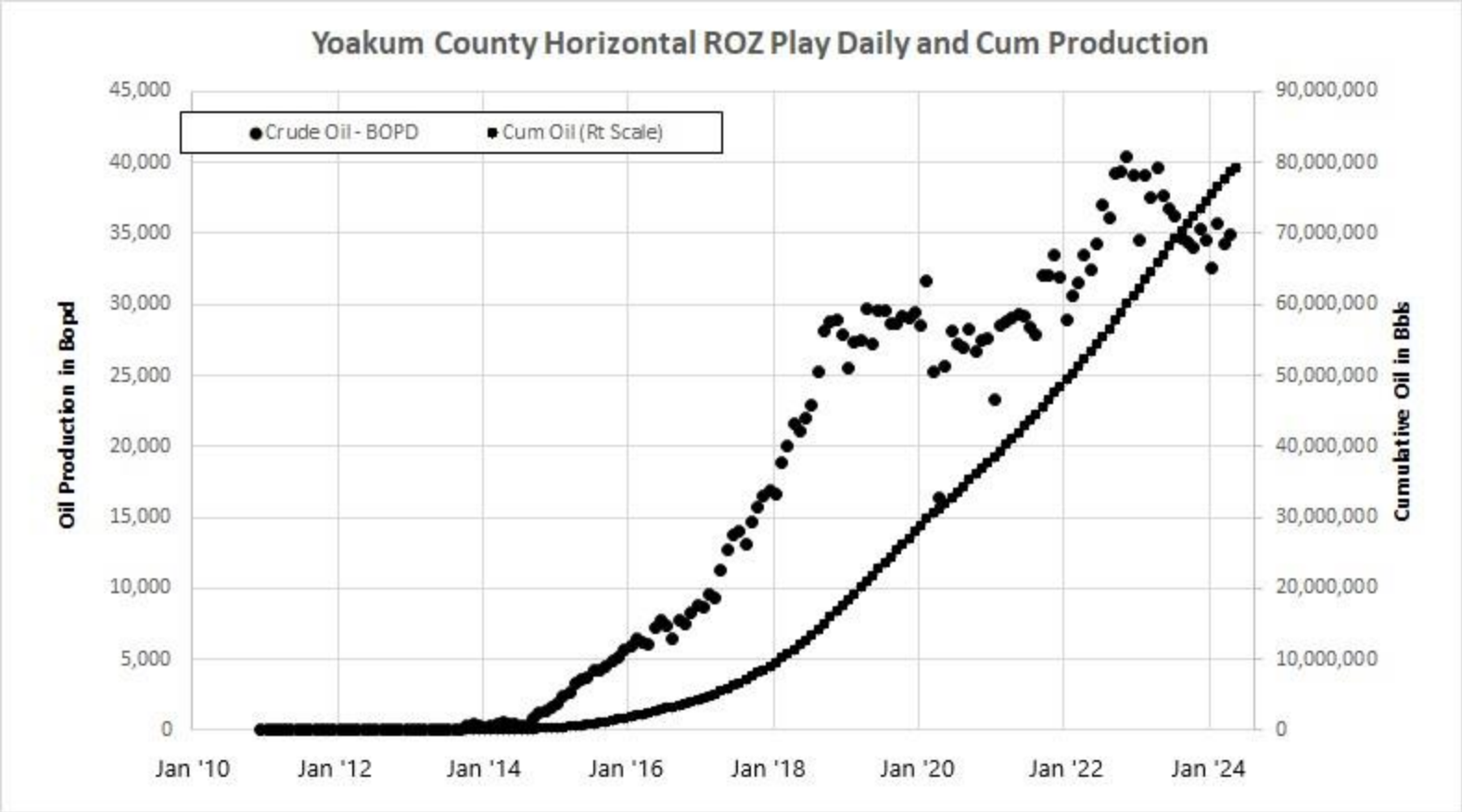
Excitement #3

Western Yoakum County Greenfield ROZ Play





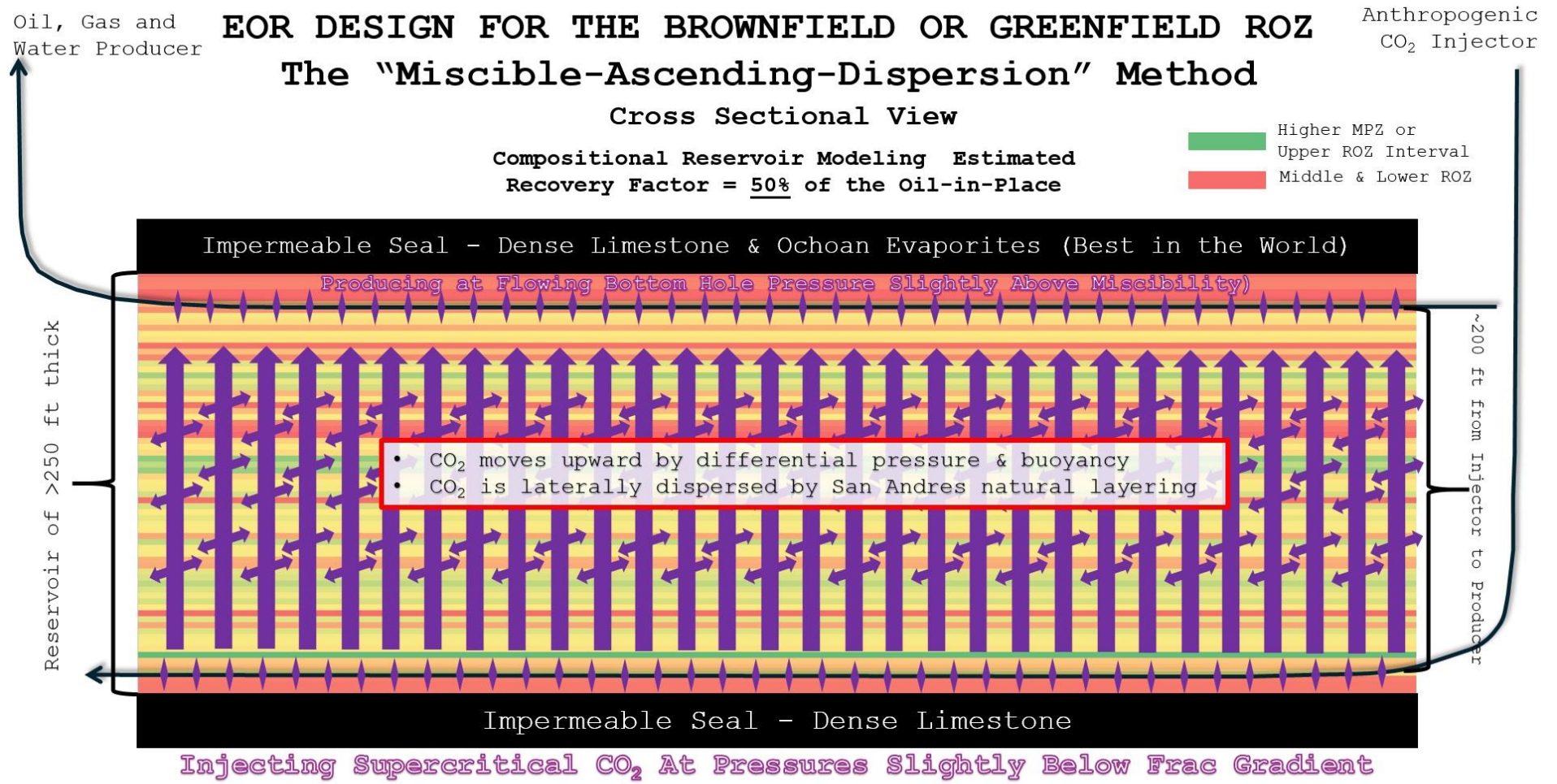
How Big is this New Horizontal Play?



Another Innovation Using Horizontal Wells

Excitement #4 in Thick ROZs

New Excitement #4:
What About Horizontals in ROZ Reservoirs?



Texas Operator Design Using Horizontal Injectors Near the Base of the ROZ

Let's Move Now to Some Horizontal Well Challenges/Barriers

- We've Seen the Huge Oil Volumes
- Produced Water Volumes are Also Huge – What to do with the Volumes for Disposal?

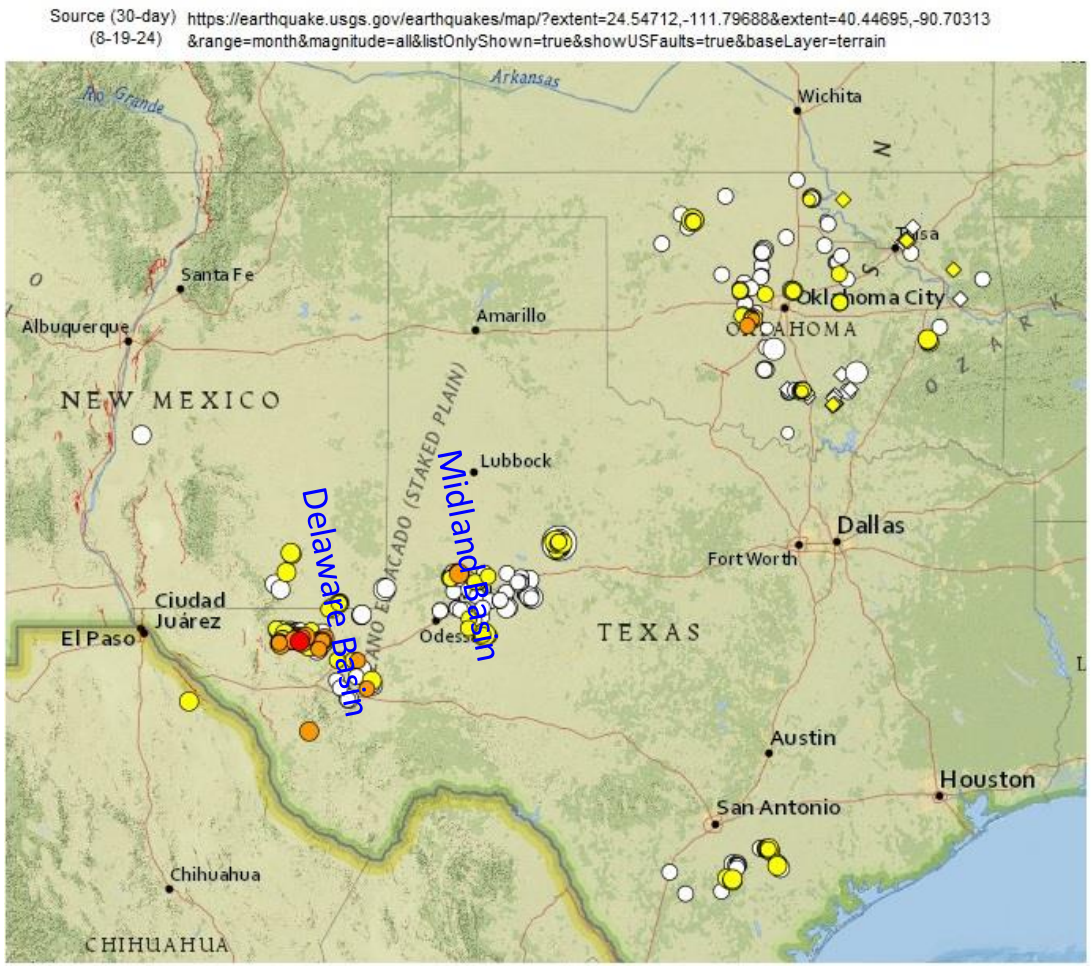
Here are Just Two of the quotes from the August '24 Produced Water Society Conference In Midland

"We're 13.7 mmBbls/day "long" (sic: produced water) in an area (PB) that needs water" John Schmitz, COB Select Water Solutions

"Tx pore space could reach injection (sic disposal) limits by 2030" John Crain, Exec VP Tx Pacific Water Resources

Continuing the Talk about Some Horizontal Well Challenges/Barriers

- Triggered Earthquakes are Occurring in all Unconventional Plays



Oklahoma, Permian, Eagle Ford to name just three

Continuing the Talk about Some Horizontal Well Challenges/Barriers

- Overpressuring of Formations and Well “Blowouts”

Water flows up from a broken old oil well in northern Pecos County in February 2023. Pu Ying Huang/The Texas Tribune

Continuing the Talk about Some Horizontal Well Challenges/Barriers

- Hard Rocks and Soft Sediments

AGU ADVANCING EARTH AND SPACE SCIENCES

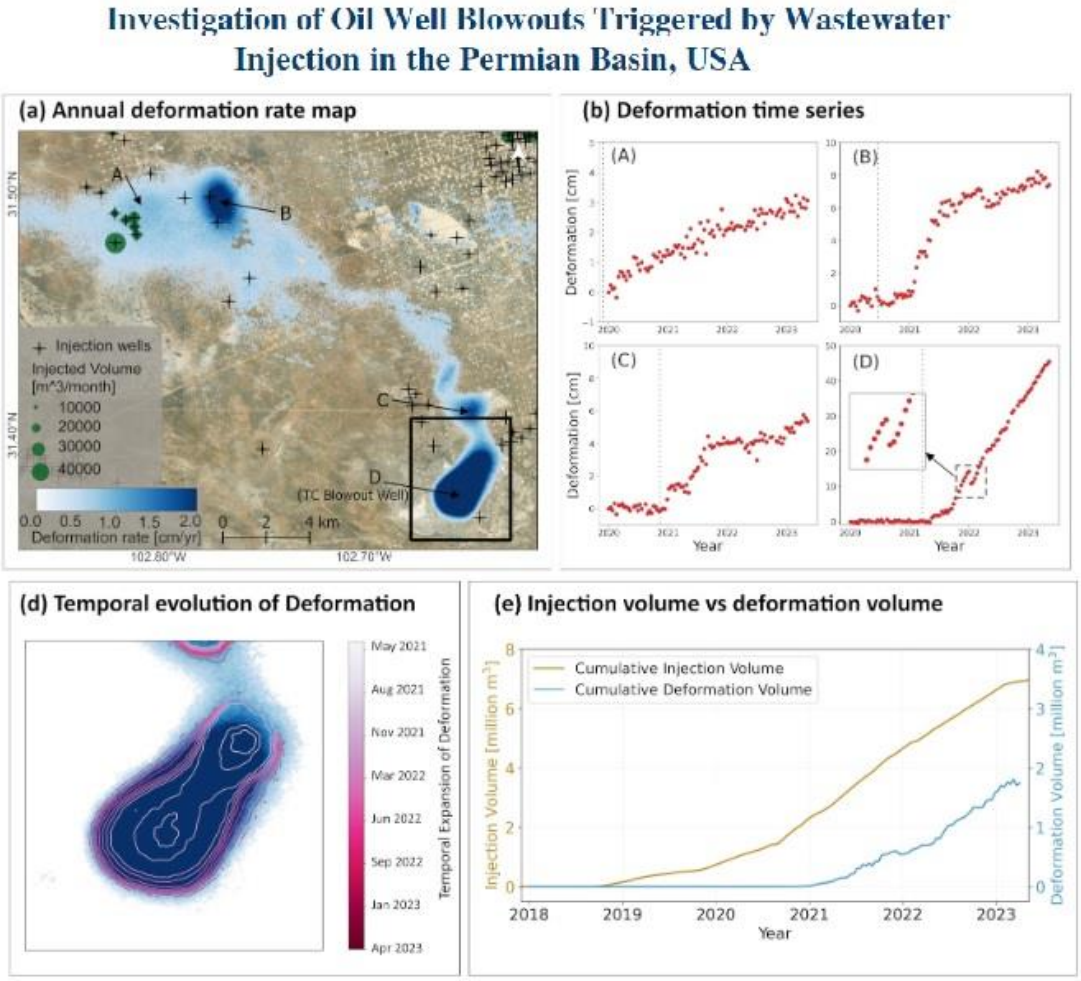
Geophysical Research Letters

Investigation of Oil Well Blowouts Triggered by Wastewater Injection in the Permian Basin, USA

Vamshi Karanam, Zhong Lu, Jin-Woo Kim

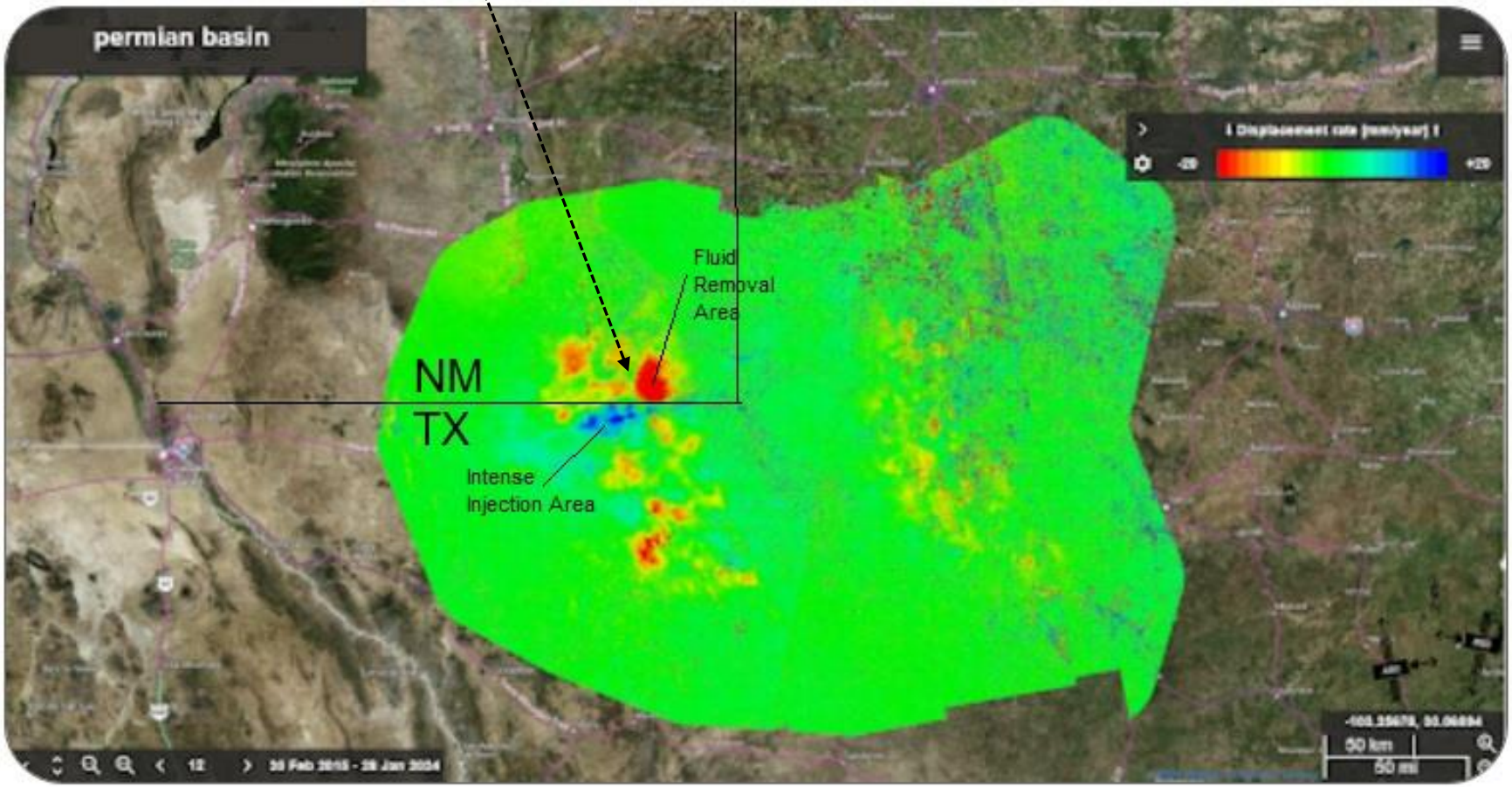
Abstract

Aged hydrocarbon wells, if proper care is not ensured, can crack, get corroded, and leak subsurface fluids. Permian Basin in Texas, home to thousands of such wells, has seen numerous blowouts and wastewater leaks. Our study employs surface deformation derived from satellite observations, and injection well records to investigate these events The results reveal an over-pressurized wastewater aquifer producing a surface uplift of 20 cm/yr, likely due to wastewater being injected tens of kilometers away. Focusing on a January 2022 blowout resulting in 3 cm subsidence in 2 weeks, our geophysical model suggests aquifer over-pressurization as the cause. With an excess pressure of over 3 MPa in the aquifer, several more such blowouts are possible in the near future. This research highlights the urgent need to better understand the impact of subsurface fluid injection and calls for prompt action to mitigate the environmental effects of oil and gas production.



INSAR Data (Surface Displacement)

Delaware Basin Displacement

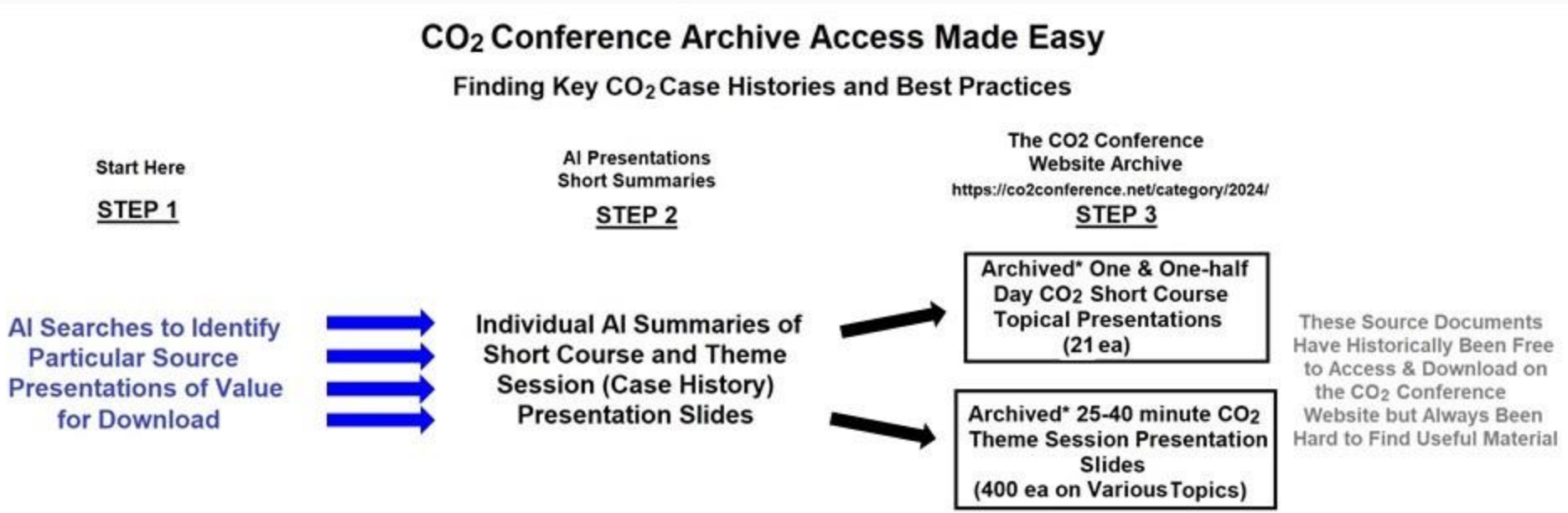


CCUS Engineering Experience

- How to Avoid the Mistakes – Learning from the Experienced and Attendees Mentoring the Newbies
- Artificial Intelligence is a Wonderful Accelerator (but care is needed)
- Here's a Great Tool We'll Be Presenting at our Conference this December

CO_2 EOR Archival Materials

The CO_2 Conference Archive
Graphical AI Access Methodology (1)



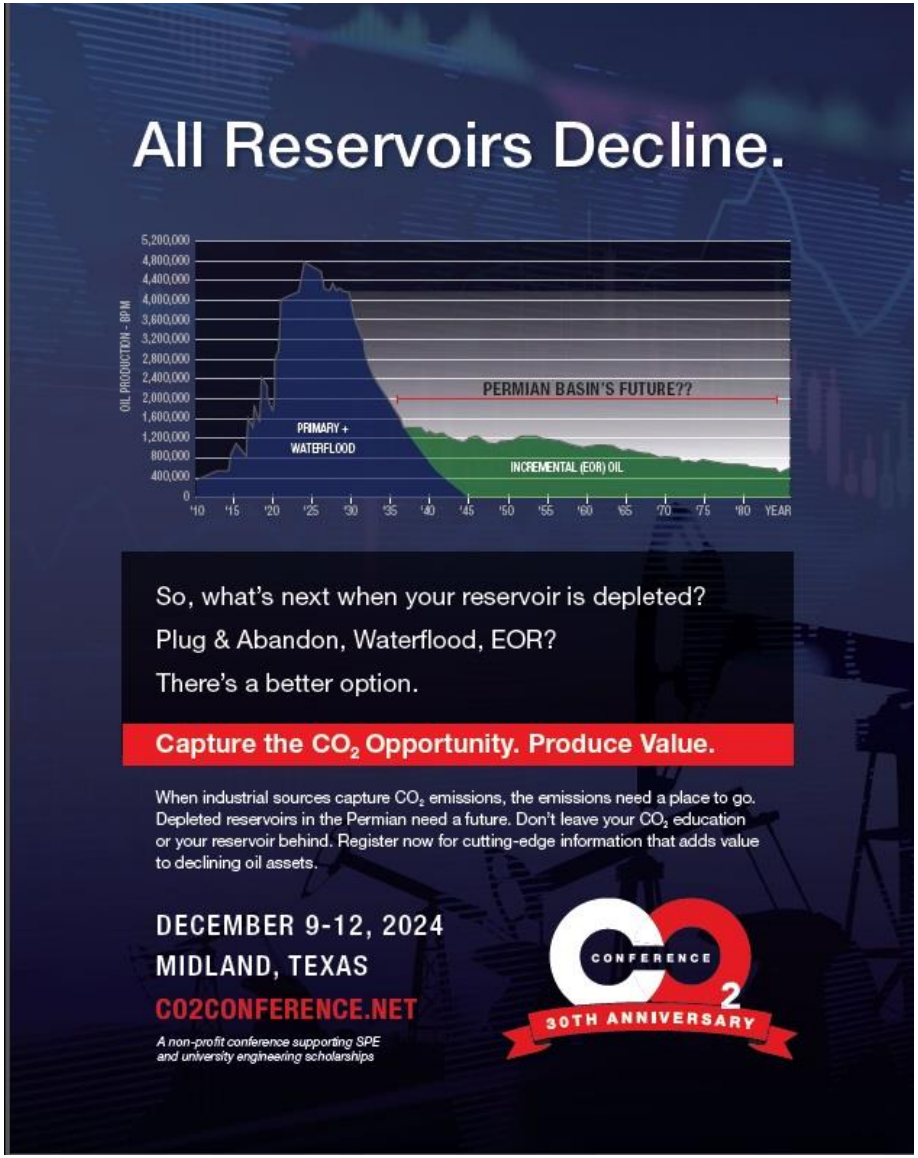
Summary

- Horizontal Wells and their Completion Technologies have Changed the Course of our Oil & Gas Industry
- The U.S. will soon be Looking at the 'Double Peak' in Oil and Gas Production – what comes on the Decline after the 2nd Peak?
- CO_2 EOR Offers Huge Promise in CCUS as CO_2 Capture Projects Proliferate Due to 45Q Tax Credit Incentive
- Innovations are not just Limited to Unconventional Reservoirs

  Excitement Abounds in Horiz Infills & in Flooding Conventional Ones as Well
- Reservoir Models Have Difficulty Handling Reservoir Continuity Issues,
  - Both Field Experience and Response Modeling can be Invaluable
- In Countering the Upsides of Horizontal Well Development, Large Volume Water Disposal has become a Huge Issue and Risks Slowing Rig Counts

After the Double Peak

We'll still Need the Oil



Thank you

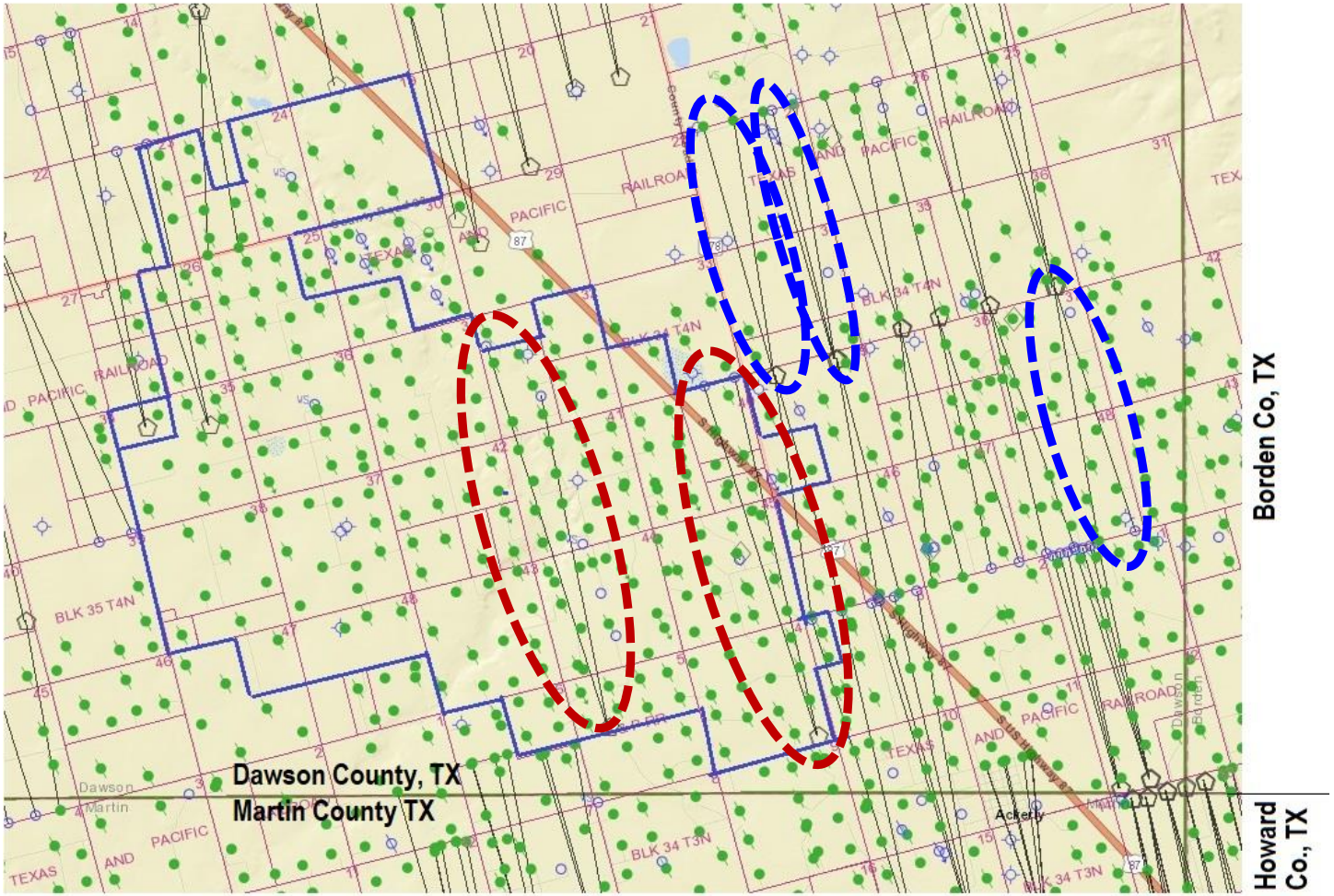
Time for Questions?

Backup Slides

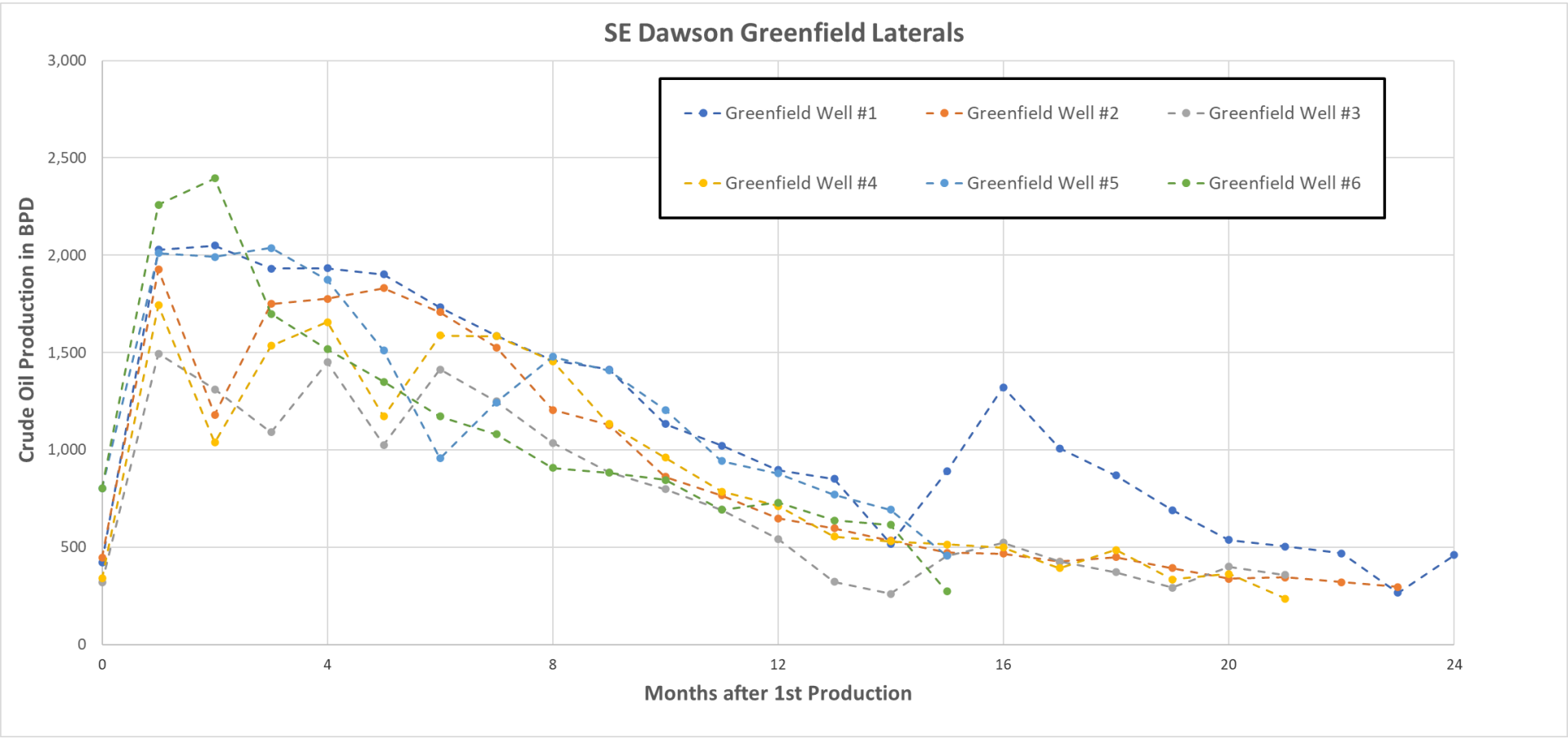
SE Dawson Green- & Brownfield Laterals

September 2025

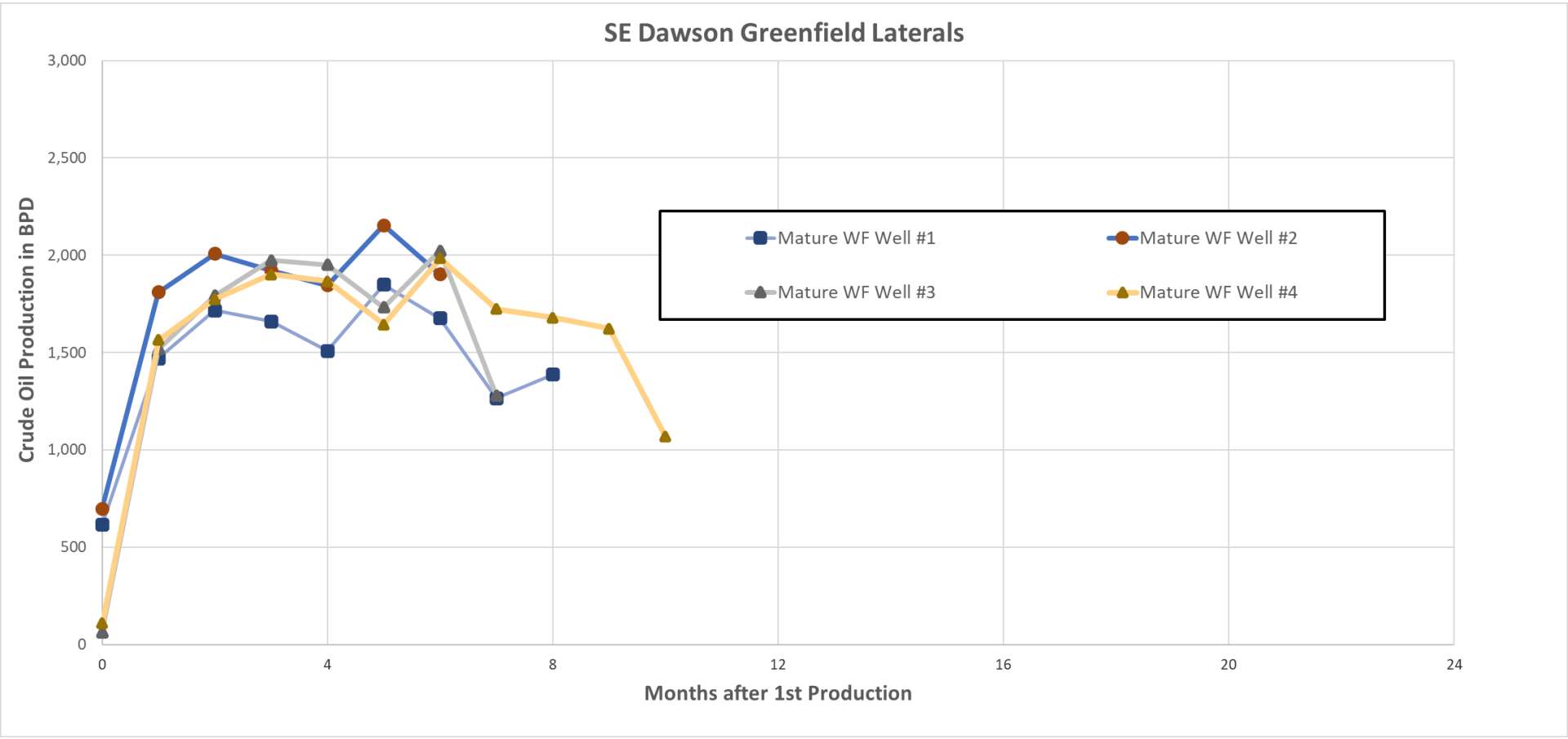
Horizontals in SE Dawson County



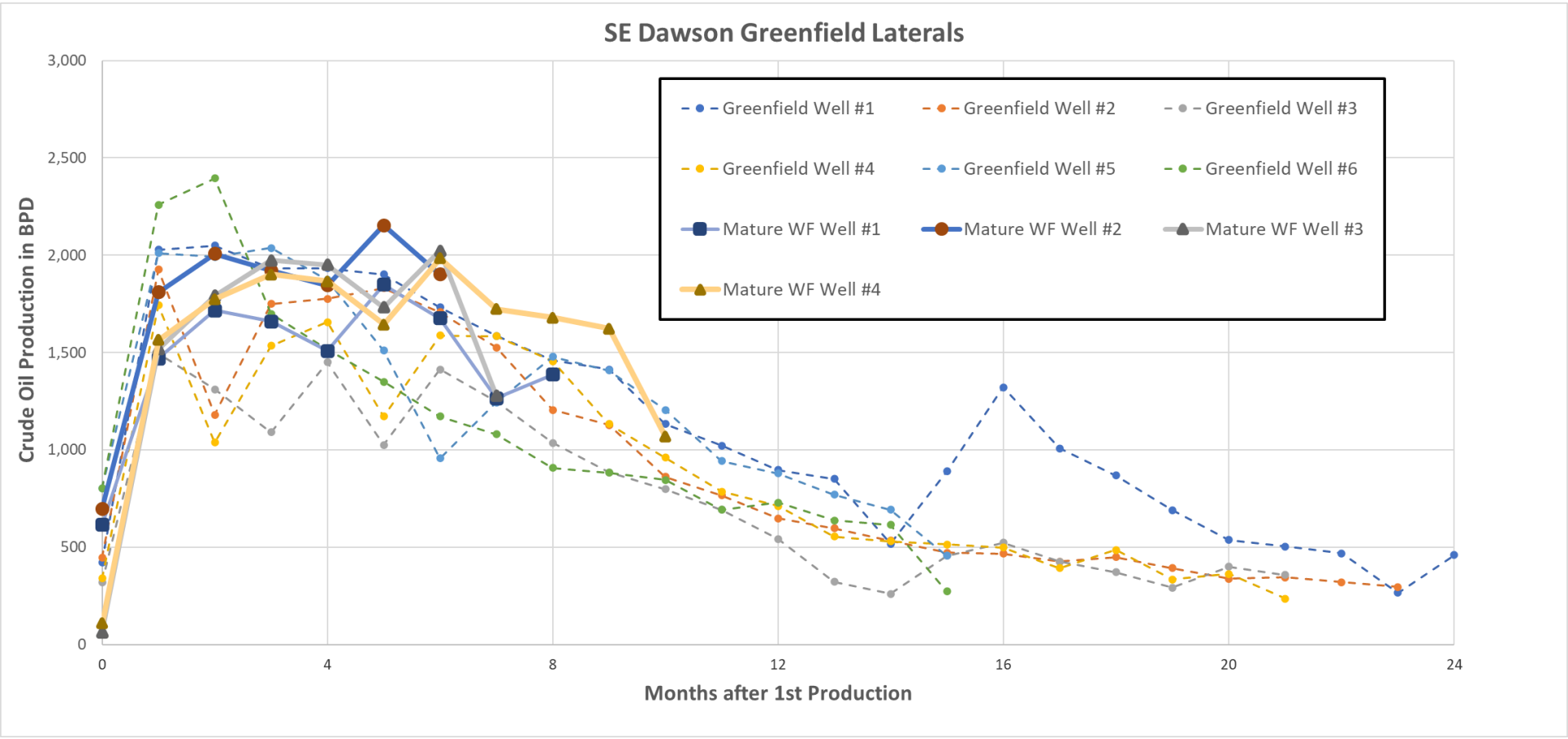
Greenfield Lateral Wells

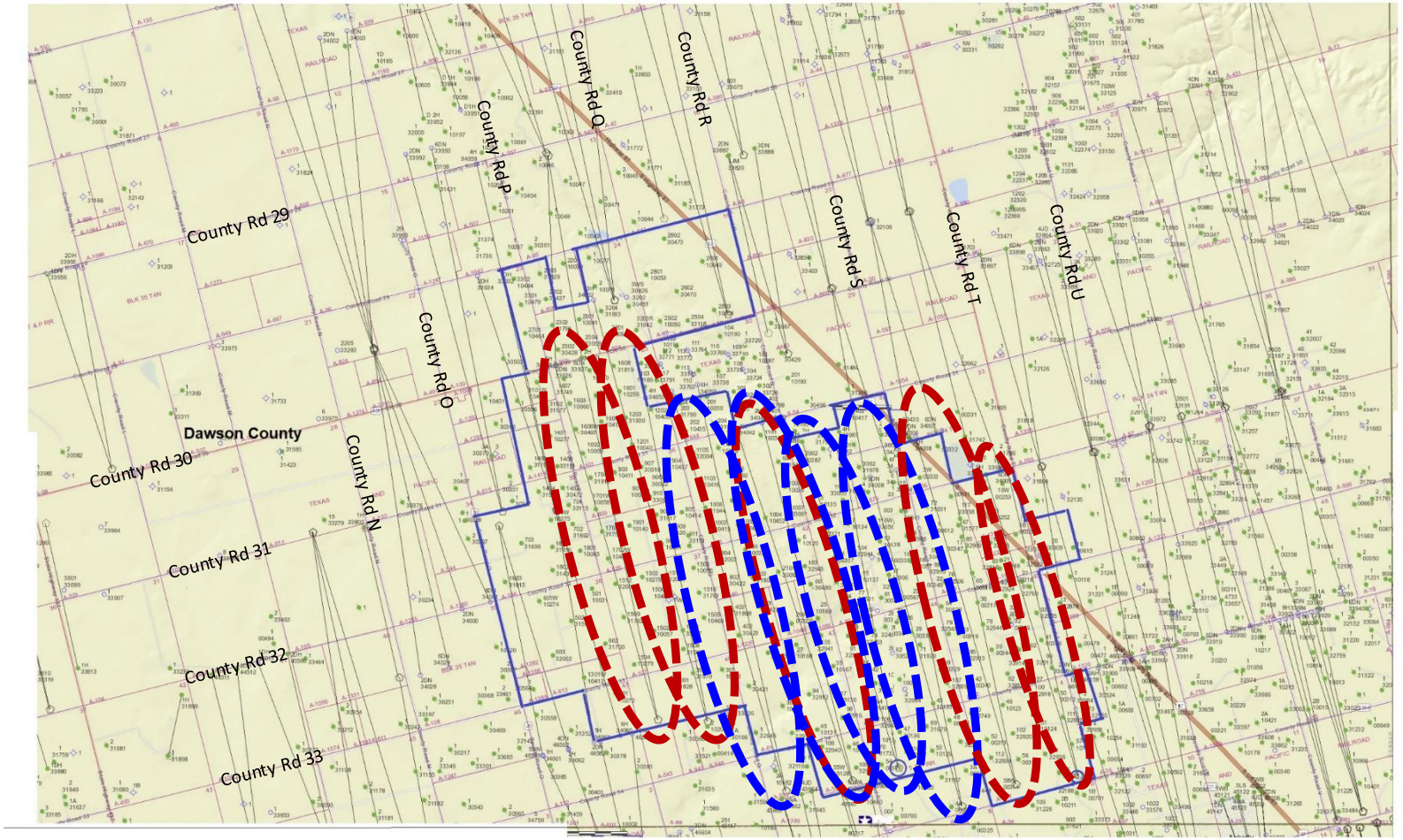


Old Waterflood Brownfield Lateral Wells



Combined


SE Dawson Greenfield Laterals
Crude Oil Production in BPD
3,000
2,500
2,000
1,500
1,000
500
0
0
4
8
12
16
20
24
Months after 1st Production
Greenfield Well #1
Greenfield Well #2
Greenfield Well #3
Greenfield Well #4
Greenfield Well #5
Greenfield Well #6
Mature WF Well #1
Mature WF Well #2
Mature WF Well #3
Mature WF Well #4

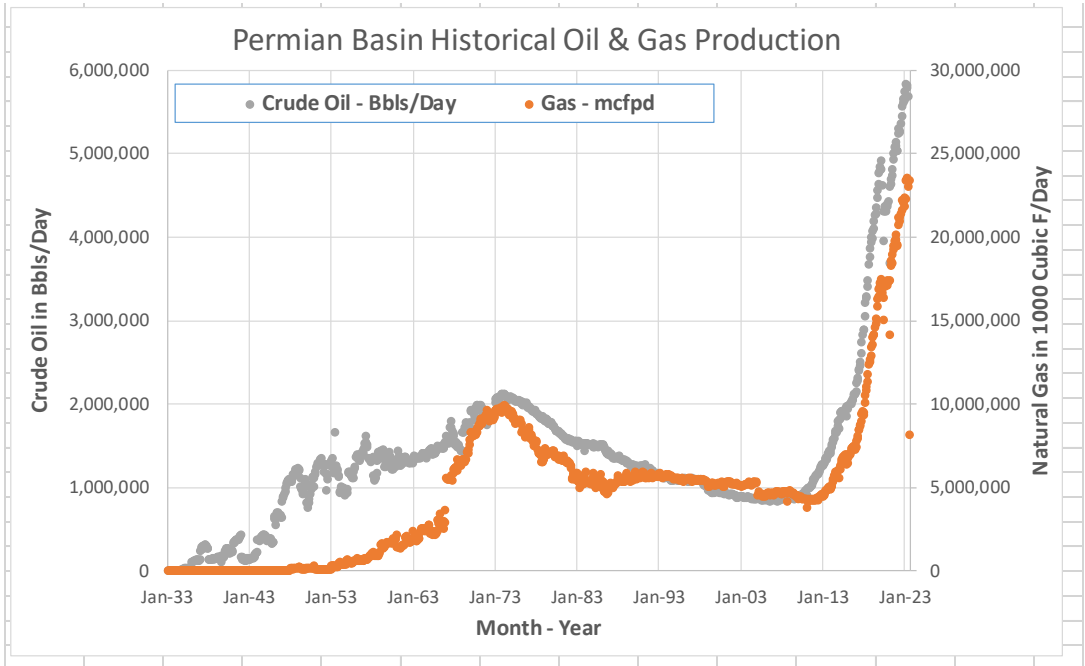


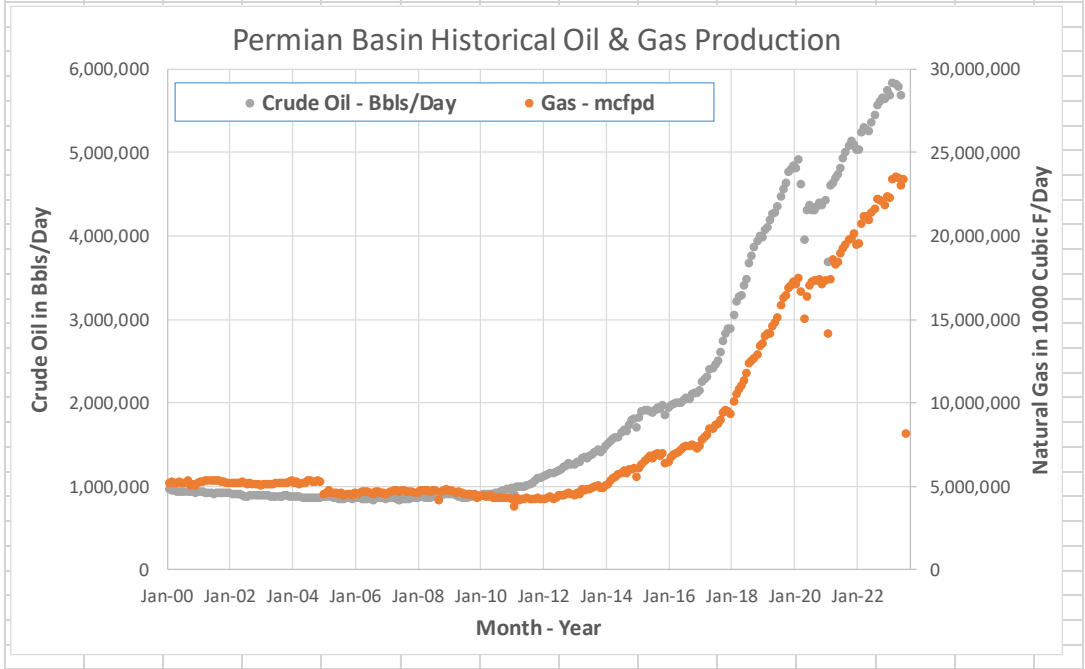
Older Existing Wells (Late 2024)

Newly Drilled Wells (Summer 2025)

Melzer Consulting

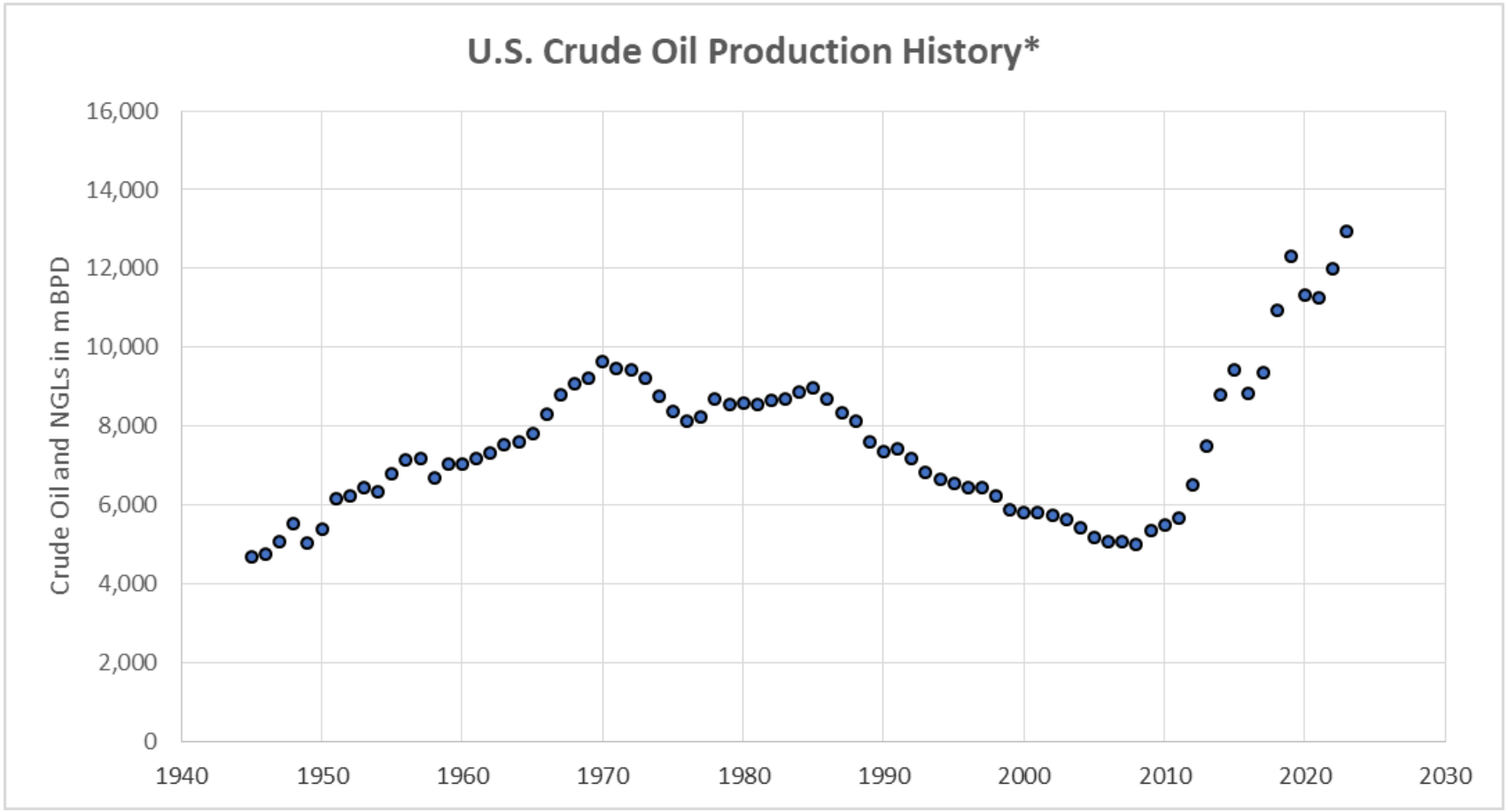
PB Daily Crude Oil and Nat'l Gas





Fixing the Occassional Mess

When will Things 'Double Peak'? (Hubbert's Update)



* Data source: U.S. Energy Information Administration
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=M_EPL2_FPF_NUS_MBBLD&f=A