Weekly E&P Update

The End of "Type Curve" Areas?

By Steve Hendrickson
President of Ralph E. Davis Associates

The current state-of-the-art in the generation of type well profiles (also called "type curves") for the prediction of the performance of future wells involves identifying a set of wells that are analogous to the proposed wells in terms of geology, reservoir characteristics, completion design and well spacing. Part of the process is identifying an area around the proposed wells' locations from which to select the analog wells, increasing the likelihood that the analog wells have similar geologic and reservoir characteristics as the proposed ones will encounter. Once this region, the "type curve area" (TCA), has been established, other factors influencing well performance can be considered in selecting the analog wells.

This approach is widely used but has some drawbacks. First, it usually results in a single type curve for all the wells in an area. This seems unlikely over large areas, so evaluators often shrink the size of the TCA's to improve granularity. This, however, leads to smaller sample sizes in each TCA, increasing the estimate's uncertainty. This approach also takes longer because it increases the number of type curves that must be derived and maintained. Finally, the boundaries of the TCA's are often arbitrary, so getting reproducible results isn't certain.

Machine learning algorithms allow one to incorporate much more information into a single model that considers the abovementioned factors (and others if the data is available). Such a model uses geographic location (such as the lat/long of the midpoint of the proposed well's trajectory) as an input, which, when combined with other inputs, generates a most-likely value for the EUR of the proposed wells at their specific locations.

Once the model is created and tuned adequately on a subset of the offset well data (the training set), it is compared to the known results of the remaining well data (the test set) to determine the model accuracy. From this comparison, the error of the model can be quantified to estimate the parameters needed to assess the reliability of the EUR estimates. These values are then used in a Monte Carlo model to determine the expected outcome of the drilling program at various confidence levels.

A final task is determining how the reserves are expected to be produced over time. This usually entails estimating decline curve parameters, such as initial rate, initial decline, and the b-factor (if Arp's hyperbolic equation is used). We'll discuss that and show an example in a future newsletter.

Table Of Contents

NYMEX FUTURE PRICING

WTI Spot Pricing

HH Spot Pricing
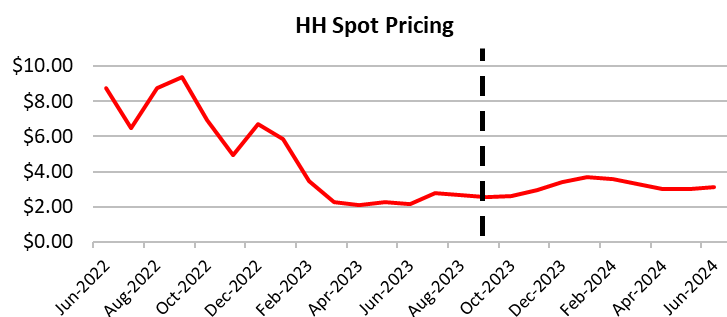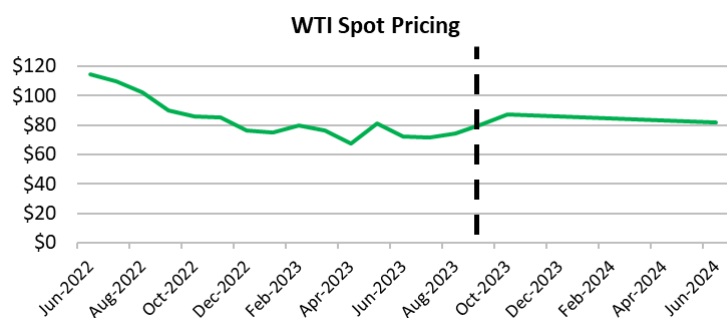
MONDAY'S MARKET CLOSE

NYMEX WTI CRUDE OIL FUTURES
as of September 11, 2023 Close ($/bbl)

Period	Current	WoW Change	Last Week	1 Yr Ago
2023	$86.63	$1.90	$84.73	$81.28
2024	$81.44	$1.55	$79.89	$74.39
2025	$75.43	$0.99	$74.44	$69.52
2026	$71.06	$0.71	$70.35	$66.06
2027	$67.59	$0.64	$66.95	$63.58

NYMEX HH NATURAL GAS FUTURES
as of September 11, 2023 Close ($/MMBtu)

Period	Current	WoW Change	Last Week	1 Yr Ago
2023	$2.98	($0.16)	$3.14	$6.06
2024	$3.41	($0.08)	$3.49	$5.05
2025	$3.92	($0.05)	$3.97	$4.87
2026	$3.92	($0.08)	$4.00	$4.85
2027	$3.85	($0.10)	$3.95	$4.93

INDUSTRY METRICS—QUICK SNAPSHOT

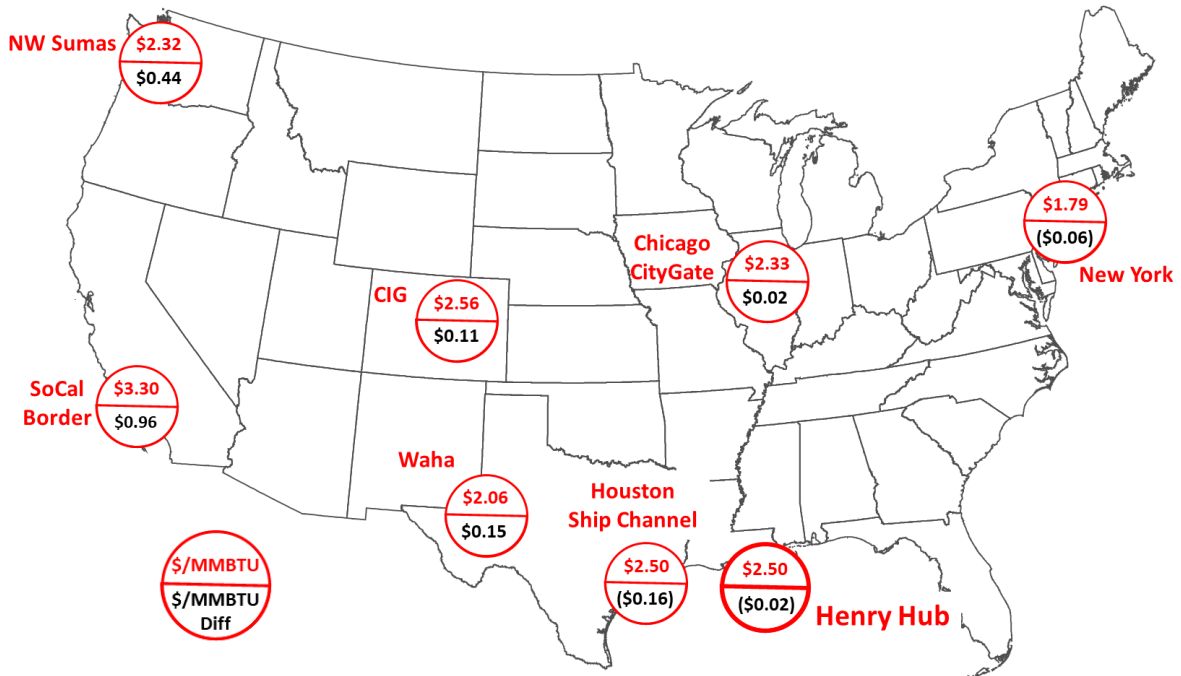|	Current	Last Week	WoW Change	%Change
Crude Oil Near-Month Price ($/bbl)	$87.40	$86.06	$1.34	2%
Natural Gas Near-Month Price ($/MMBtu)	$2.61	$2.70	($0.09)	(3%)
Weekly Upstream-Deal Transaction Value ($MM)	$1,564.70	$0.00	$1,564.70	-
Weekly Number of Upstream-Deal Transactions	4	1	3	300%
Current Total US Rig Count	632	631	1	0.2%
US Field Crude Oil Production (MMbbl/day)	12.8	12.8	0	-
US Field Dry Natural Gas Production (Bcf/day)	107.9	108.8	(0.9)	(0.8%)
Commercial Crude Oil Stocks-Excluding SPR (MMbbl)	417	423	(6)	(2%)
Natural Gas Stocks-Working Gas Underground Storage (Bcf)	3,148	3,115	33	1%
Total Drilled But Uncompleted Wells (DUC-Last Month)	4,787	4,787	0	-

US COMMODITY PRICES CONTINUED

Natural Gas Pricing & Change From Previous Week ($/MMBtu)

Location	Price	Change
NW Sumas	$2.32	$0.44
New York	$1.79	($0.06)
Chicago CityGate	$2.33	$0.02
CIG	$2.56	$0.11
SoCal Border	$3.30	$0.96
Waha	$2.06	$0.15
Houston Ship Channel	$2.50	($0.16)
Henry Hub	$2.50	($0.02)

Legend: $/MMBTU / $/MMBTU Diff

Oil Pricing & Change From Previous Week ($/bbl)

Location	Price	Change
Clearbrook	$88.94	$2.24
East Coast US Brent	$92.07	$1.37
Cushing	$87.29	$1.74
West Coast ANS CIF	$94.89	$2.34
Midland	$88.68	$1.93
St. James LLS	$89.49	$1.64

Legend: $/bbl / $/bbl Diff
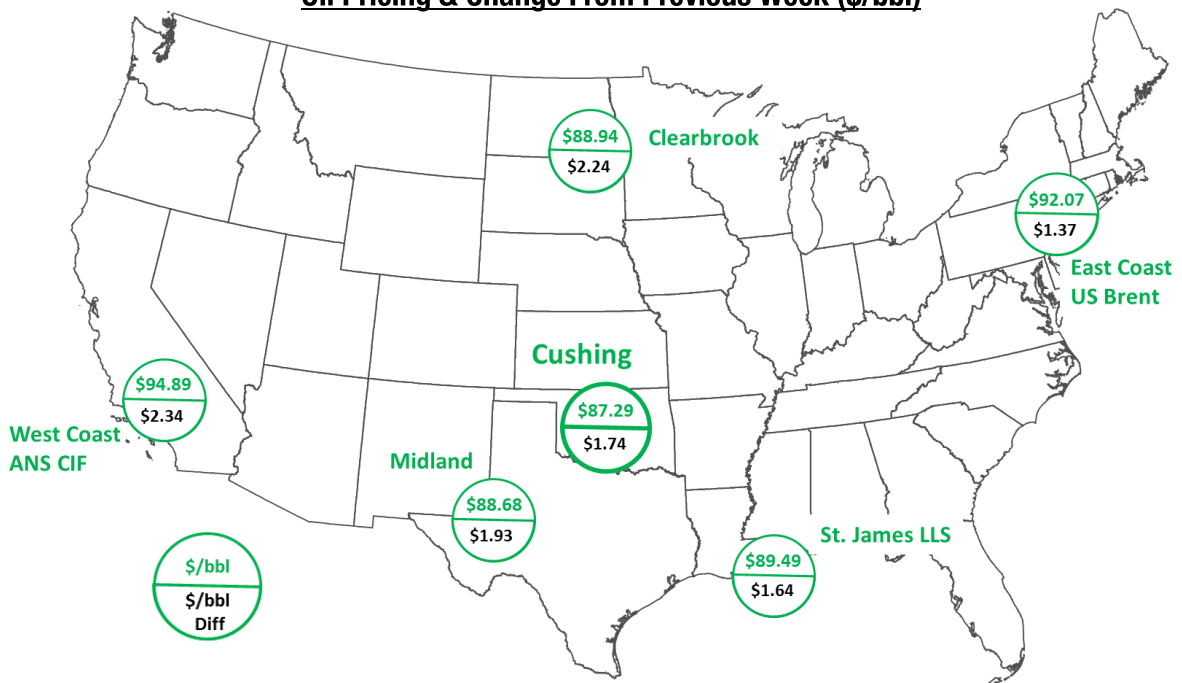
*Source—Bloomberg LP

SELECTED INDUSTRY HEADLINES

USA Crude Oil Stocks Drop Again
U.S. commercial crude oil inventories, excluding those in the Strategic Petroleum Reserve (SPR), decreased by 6.3 million barrels from the week to week, the U.S. Energy Information Administration's (EIA) latest petroleum status report showed.

API: Cancellation of Alaska Leases Sets Concerning Precedent
The American Petroleum Institute (API) has condemned the rescindment of oil and gas leases covering over 430,000 acres in the Arctic National Wildlife Refuge, warning the latest tightening on the industry by the Biden administration sets a "concerning precedent".

Oil Steadies As Traders Await OPEC Report (LOGIN CREDENTIALS REQUIRED)
0800 GMT – Brent crude oil holds close to $90 a barrel for a third day in a row as the market awaits forecasts from OPEC and the IEA on oil demand.

At What Level Will Saudi Arabia And Russia Stop Pushing Oil Prices Higher
The recent decisions by Saudi Arabia to continue its 1 million barrel per day (bpd) production cut to the end of this year and by Russia to extend its 300,000 barrels per day export cut for the same period conspired to push oil prices to their highest level since last November.

Guyana's Oil Boom Challenges OPEC Dominance
Guyana is expected to pump 1.2 million barrels of crude oil per day by 2027, surpassing many OPEC members, driven by Exxon's development of the Stabroek Block.

Ukraine Regains Control Of Black Sea Oil, Gas Drilling Platforms Captured By Russian Forces
Ukraine's military intelligence service said its forces regained control of several oil and gas drilling platforms in the Black Sea that were used by Russia for stationing helicopters and radar activity.

Factbox: China's Oil Trade And Investment In Venezuela
Venezuela President Nicolas Maduro has arrived in Beijing for a visit that will likely feature energy and debt repayment talks against a backdrop of China's souring relations with the West.

Saudi Arabia Stresses Commitment To Being Reliable Source Of Crude Oil Supplies To India –Joint Statement
Saudi Arabia is committed to being a reliable partner and source of crude oil supplies to India, according to a joint statement by the two countries released recently.

U.S. Oil Drilling Rig Count Increases For First Time Since June 2023
The number of oil rigs operating in the U.S. increased this week for the first time since June as crude prices soared, but drilling remains well below where it was at the beginning of the year.

Industry Leaders Discuss Emissions Reduction Technologies At Gastech 2023
At the third day of Gastech 2023, senior ministers, business leaders, and global climate specialists reached consensus on the steps required to develop new solutions to reduce carbon emissions and accelerate climate technologies.

UK Offshore Wind Auction Receives Zero Bids, Puts Industry At Risk
Recently an auction for contracts to build new wind farms received zero bids from developers. It's the first time that's happened since the current system was introduced almost a decade ago, and it raises major questions about the UK's environmental targets.

Electric Vehicle Industry's Future Could Unseat Tesla & BYD (LOGIN CREDENTIALS REQUIRED)
The transportation "majors" are making their inroads into the multiyear shift to electric.

SELECTED RECENT TRANSACTIONS

Magnolia Oil & Gas Announces Bolt-On Asset Acquisition in Giddings
Magnolia Oil & Gas Corporation announced recently that the Company has entered into a definitive purchase agreement to acquire certain oil and gas producing properties including leasehold and mineral interests in Giddings for $300 million, subject to customary purchase price adjustments.

Viper Energy Partners LP, A Subsidiary Of Diamondback Energy, Inc., Announces Acquisition
Viper Energy Partners LP, recently announced it has entered into a definitive purchase and sale agreement to acquire certain mineral and royalty interests from affiliates of Warwick Capital Partners and GRP Energy Capital in exchange for approximately 9.02 million Viper common units and $750 million of cash, subject to customary adjustments.

Phoenix Capital Group Purchases Assets in North Dakota
Phoenix Capital Group, a leading oil and gas mineral rights acquisition company, has announced the purchase of roughly 2,530 net acres of land in Mountrail County, North Dakota valued at roughly $9 million.

Crescent Energy to Acquire Additional Interests in its Operated Western Eagle Ford Position
Crescent Energy Company recently announced that it has entered into a definitive purchase agreement to acquire incremental working interest in its operated Western Eagle Ford assets for total consideration of $250 million in cash, subject to customary purchase price adjustments.

Dorchester Minerals, L.P. Completes Acquisition of Mineral and Royalty Interests
Dorchester Minerals, L.P. announced that it has completed an acquisition of mineral and royalty interests totaling approximately 3,355 gross acres and 568 net royalty acres located in three counties in Texas.

Permian Resources To Buy Earthstone In $4.5 bln Deal
Permian Resources said it would buy Earthstone Energy in an all-stock transaction valued at about $4.5 billion, including debt, boosting the shale producer's presence in the Delaware Basin.

Crescent Point Announces Sale Of Its North Dakota Assets
Crescent Point Energy Corp. is pleased to announce that it has entered into an agreement with a private operator to sell its North Dakota assets for US$500 million.

PHX Minerals Announces Accretive Acquisitions in Haynesville and SCOOP
PHX Minerals Inc. announced that it has agreed to acquire approximately 988 net royalty acres targeting the Haynesville play in Louisiana and Texas and the SCOOP play in Oklahoma from five separate sellers for aggregate consideration of $13.6 million in cash subject to certain closing conditions and adjustments.

Empire Petroleum Announces Acquisition Of Additional Interests In New Mexico Units
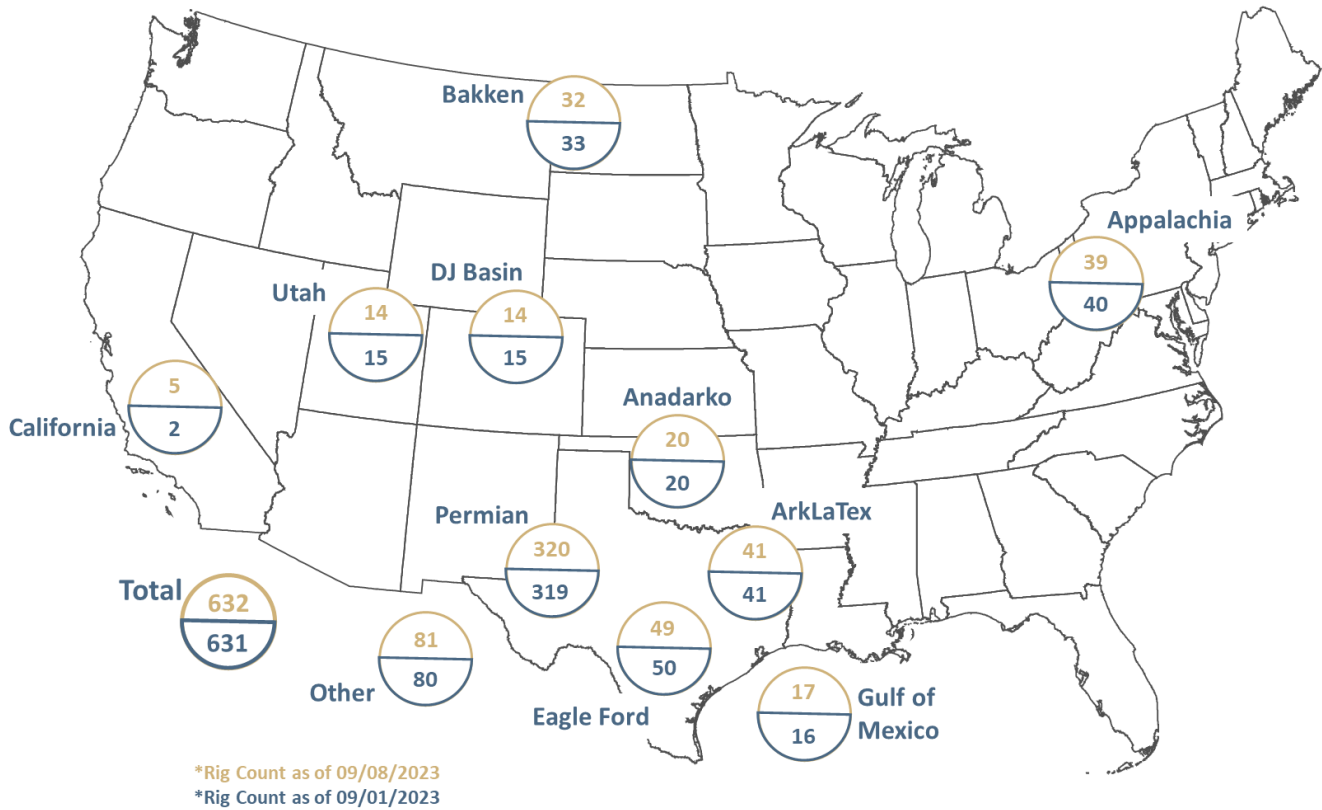Empire Petroleum announced that it closed on the acquisition of COERT Holdings 1 LLC's interests in Empire's three New Mexico assets, Eunice Monument South Unit A, Eunice Monument South Unit B, and Arrowhead Grayburg Unit, all of which are located in Lea County. The purchase price for the Transaction was approximately $6.7 million.

ExxonMobil Announces Acquisition Of Denbury
Exxon Mobil Corporation announced it has entered into a definitive agreement to acquire Denbury Inc., an experienced developer of carbon capture, utilization and storage (CCS) solutions and enhanced oil recovery. The acquisition is an all-stock transaction valued at $4.9 billion, or $89.45 per share based on ExxonMobil's closing price recently.

Bakken 32 / 33
Appalachia 39 / 40
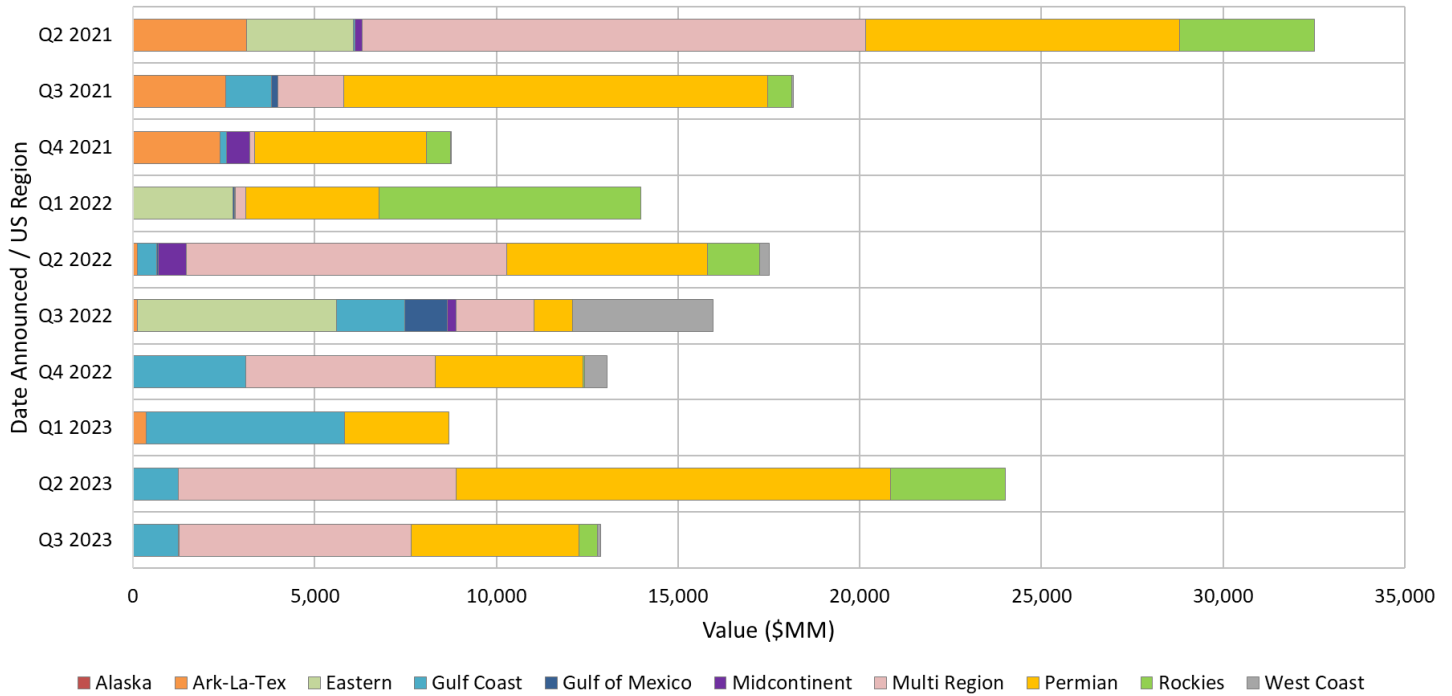Utah 14 / 15
DJ Basin 14 / 15
California 5 / 2
Anadarko 20 / 20
Permian 320 / 319
ArkLaTex 41 / 41
Total 632 / 631
Other 81 / 80
Eagle Ford 49 / 50
Gulf of Mexico 17 / 16

*Rig Count as of 09/08/2023
*Rig Count as of 09/01/2023

U.S. Rig Breakouts	Week Ending 09/08/2023		Week Ending 09/01/2023		Week Ending 09/09/2022
	Count	+/-	Count	+/-	Count
Oil	513	1	512	(78)	591
Gas	113	(1)	114	(53)	166
Not Specified	6	1	5	4	2
Directional	56	5	51	13	43
Horizontal	562	(4)	566	(130)	692
Vertical	14	0	14	(10)	24
Land (Inc Others)	610	(1)	611	(131)	741
Inland Waters	3	0	3	0	3
Offshore	19	2	17	4	15
US Total	632	1	631	(127)	759

*Source—Baker Hughes Weekly Rig Counts

DEAL VALUE BY US REGION (BY QUARTER)

Legend: ■ Alaska ■ Ark-La-Tex ■ Eastern ■ Gulf Coast ■ Gulf of Mexico ■ Midcontinent ■ Multi Region ■ Permian ■ Rockies ■ West Coast

DEAL VALUE BY US REGION (BY YEAR)

Legend: ■ Alaska ■ Ark-La-Tex ■ Eastern ■ Gulf Coast ■ Gulf of Mexico ■ Midcontinent ■ Multi Region ■ Permian ■ Rockies ■ West Coast
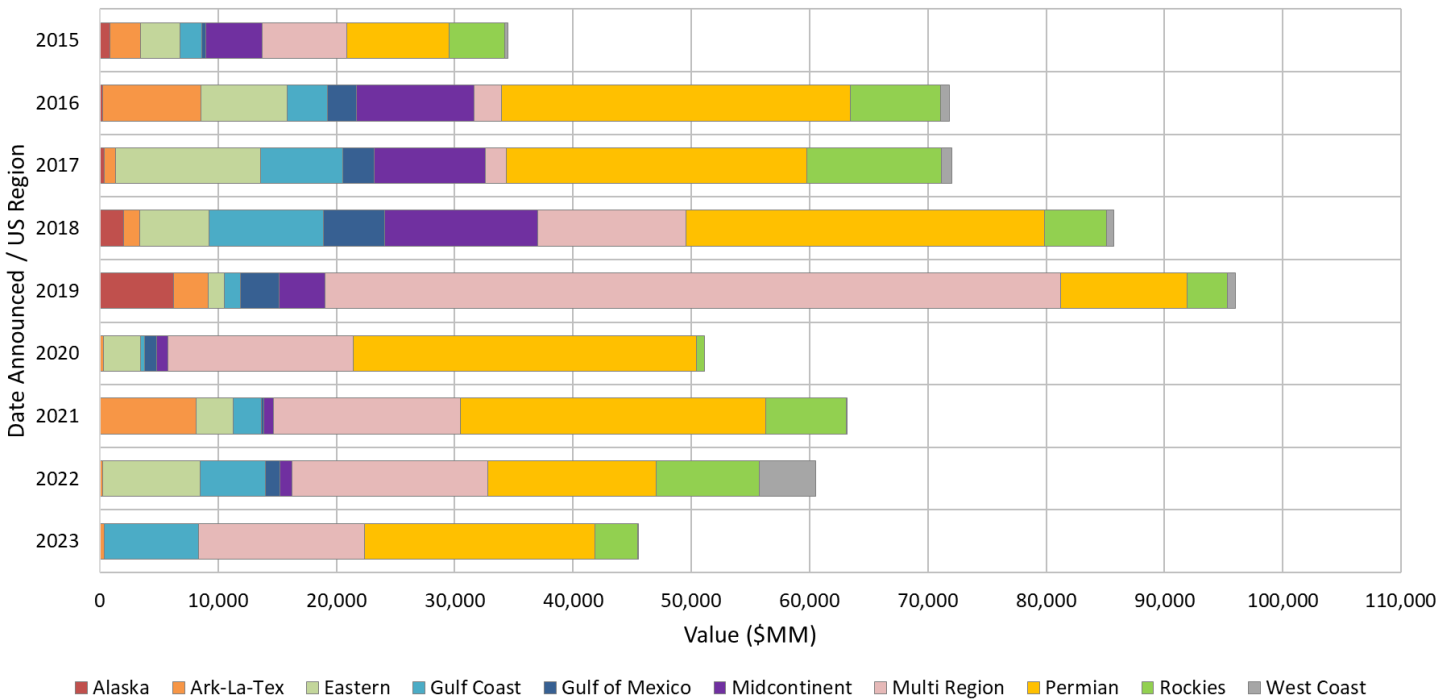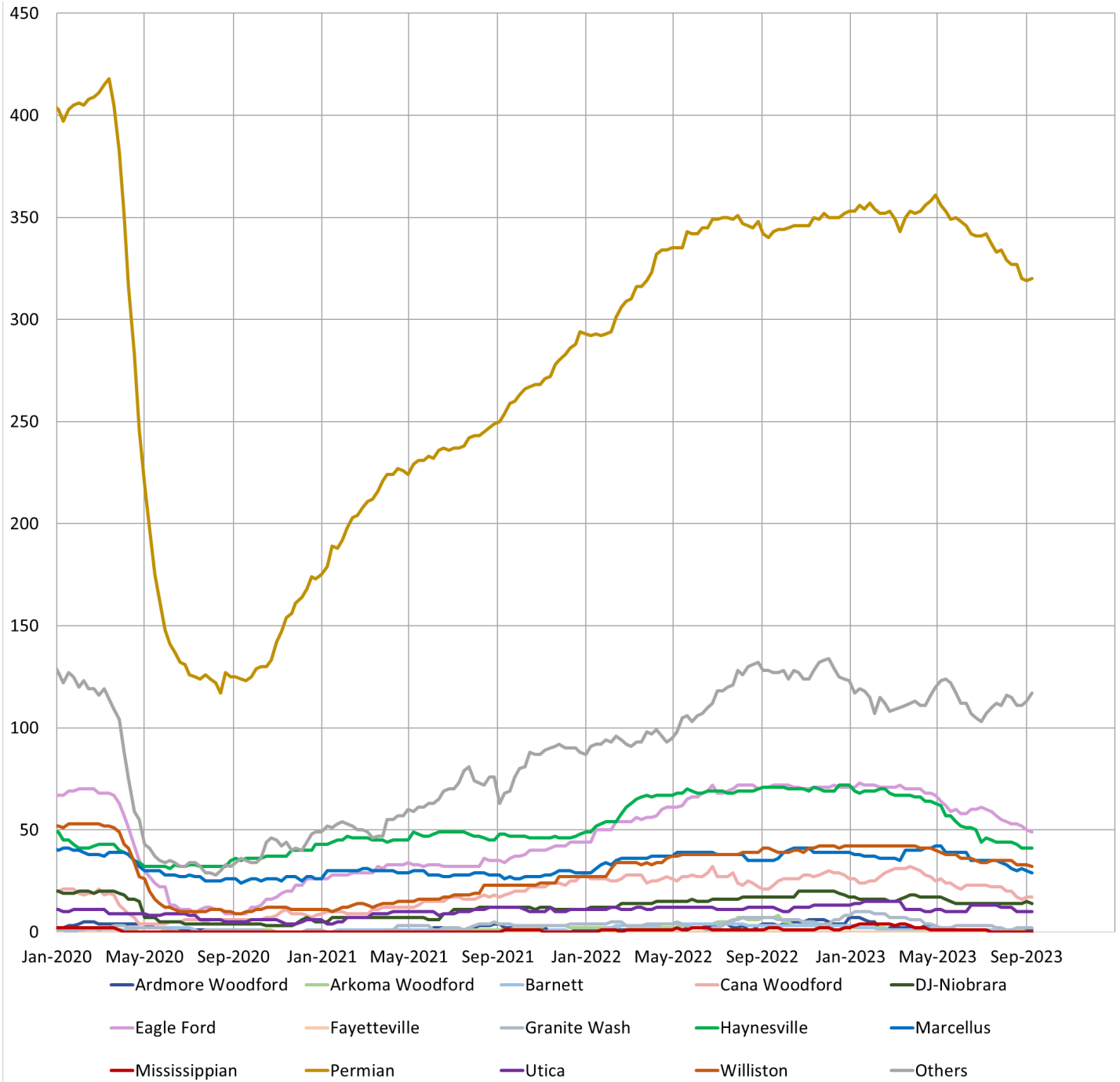
*Source—PLS M&A Database   (Charts exclude terminated deals)
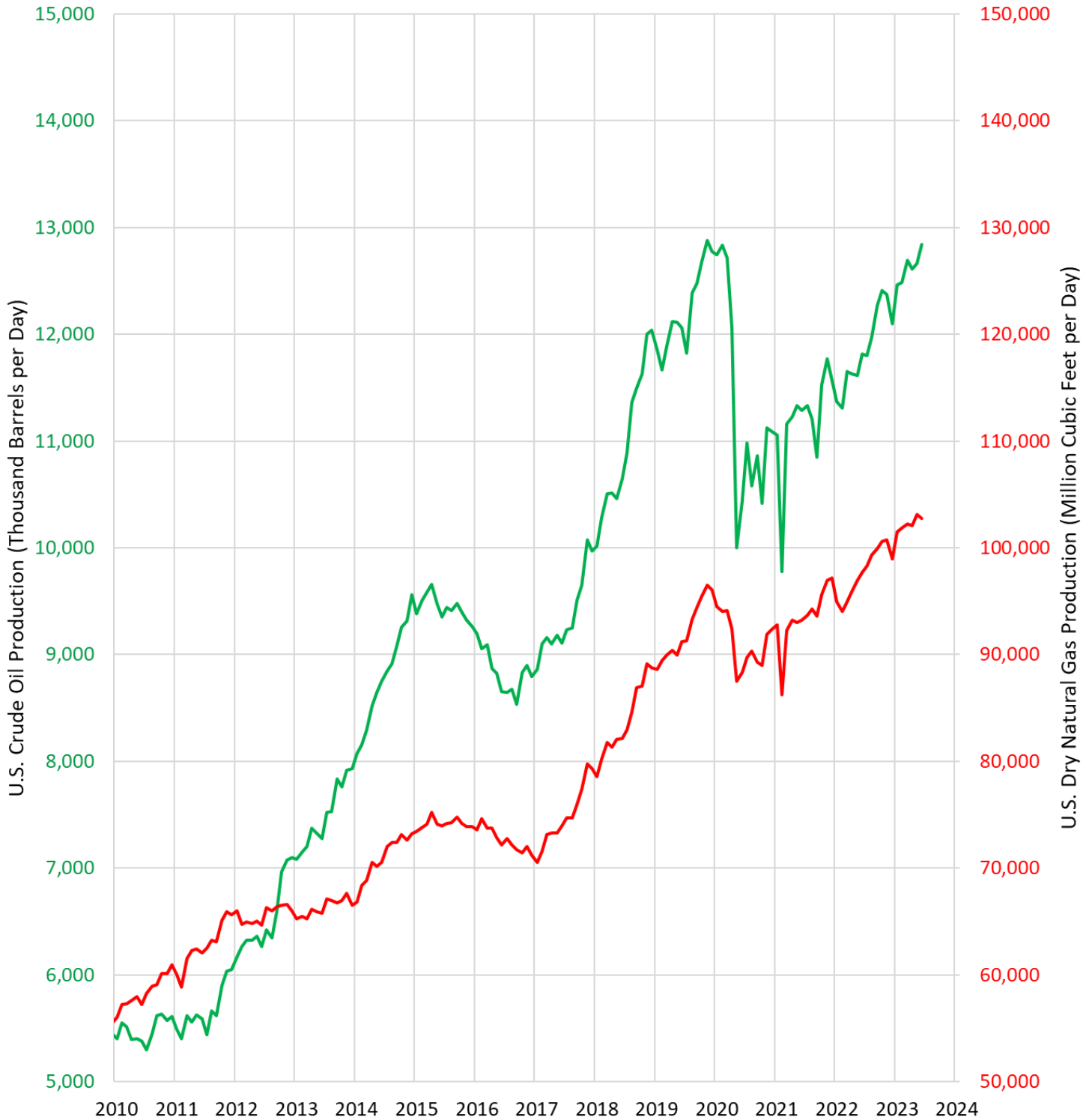
RIG ACTIVITY BY US REGION

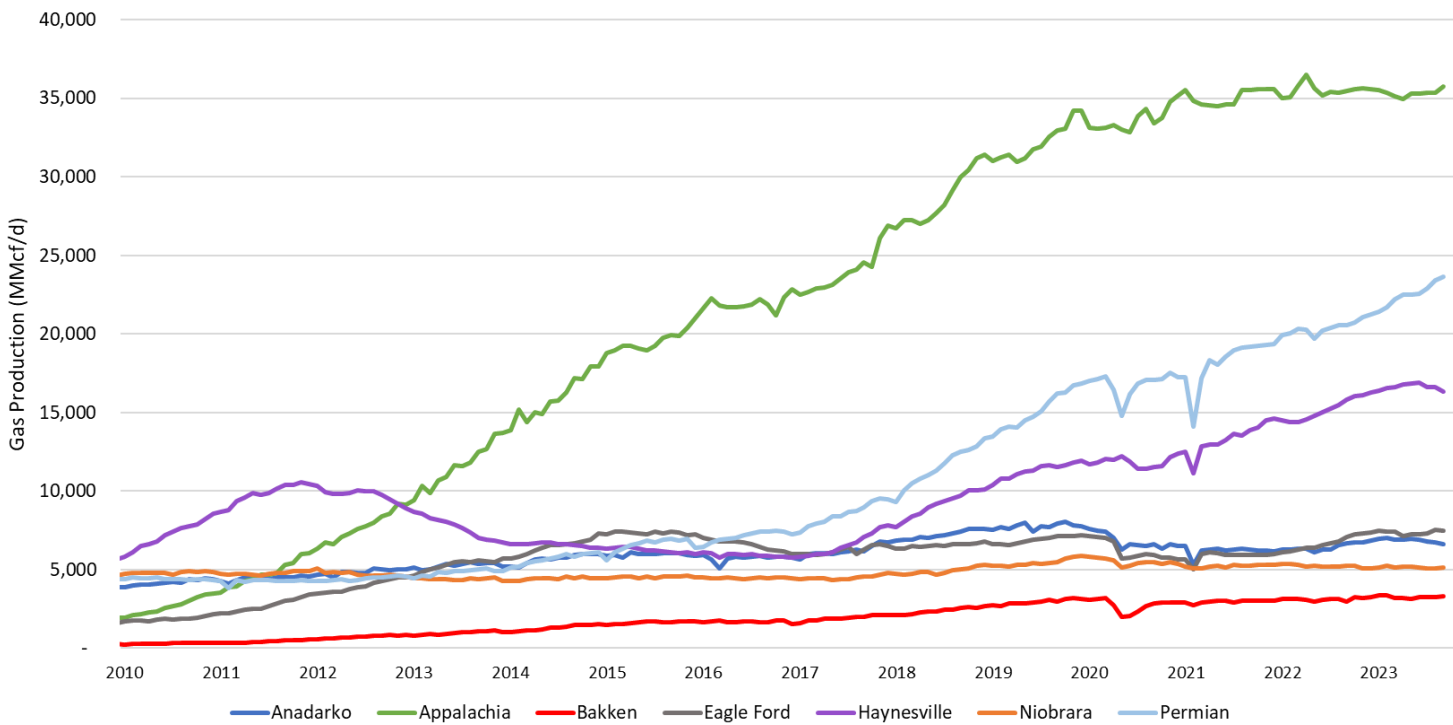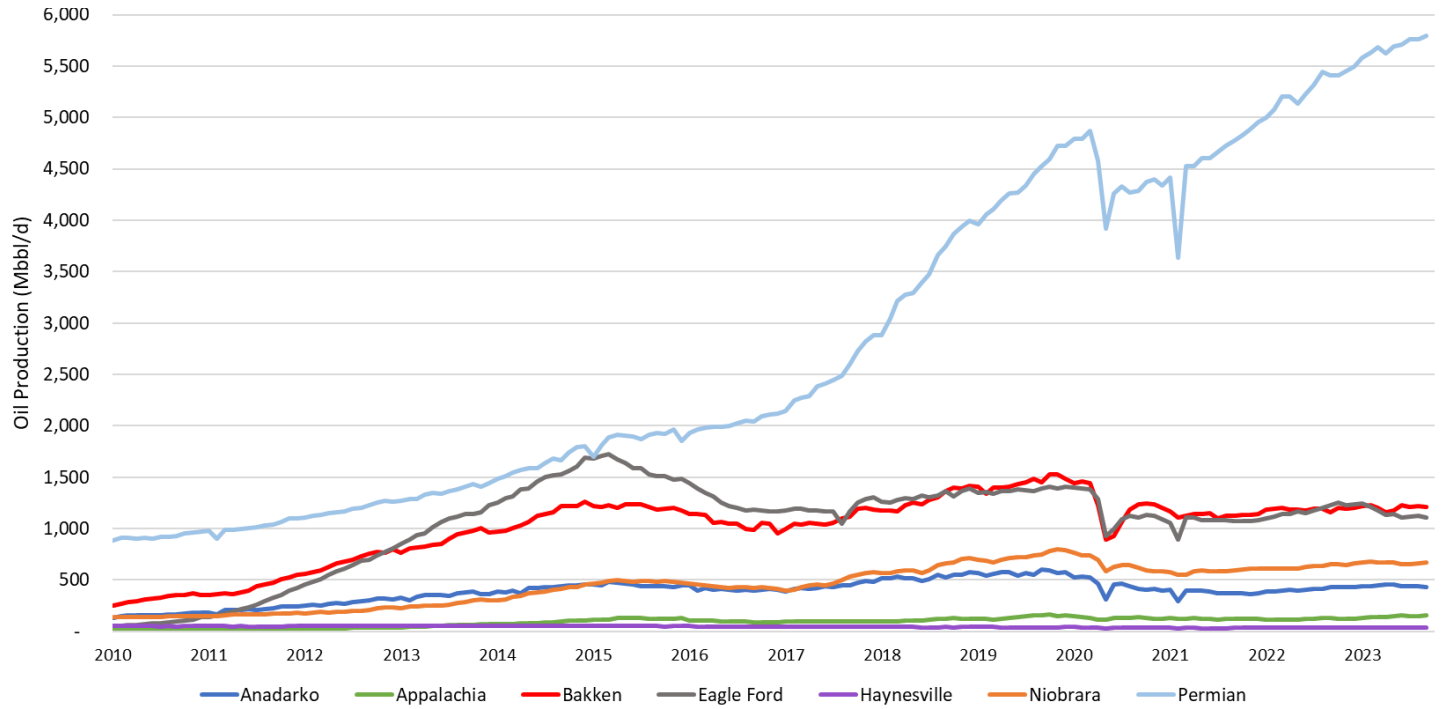*Source—Baker Hughes Weekly Rig Counts

US DAILY CRUDE (MMbbl) & DRY NATURAL GAS PRODUCTION (MMcf)

*Source—Energy Information Administration, United States (EIA)

HISTORICAL PRODUCTION OF SELECTED US SHALE REGIONS

Oil Production (Mbbl/d) chart, 2010–2023, with series: Anadarko, Appalachia, Bakken, Eagle Ford, Haynesville, Niobrara, Permian

Gas Production (MMcf/d) chart, 2010–2023, with series: Anadarko, Appalachia, Bakken, Eagle Ford, Haynesville, Niobrara, Permian

*Source—Energy Information Administration, United States (EIA)

UPCOMING EVENTS

September 2023		
YPE 11th Annual Clay Shoot For A Cause	September 12	Houston, TX
DCAC Art For Advocacy	September 16	Dallas, TX
SEARCH 3rd Annual Cornhole Tournament	September 20	Houston, TX
SPE Business Development – Permian Panel	September 20	Houston, TX
HEFG Wine and Whiskey Event	September 21	Houston, TX
Enertia User Conference	September 21-22	Fort Lauderdale, FL
HPF 29th Annual Golf Tournament	September 25	Cypress, TX
World Oilman's Overnight Poker Tournament (WOOP)	September 28-29	Lake Charles, LA

October 2023		
Hart Energy—Energy Capital Conference	October 2	Dallas, TX
Hart Energy—A&D Strategies and Opportunities Conference	October 3	Dallas, TX
2023 National Conference of Bankruptcy Judges (NCBJ)	October 11-14	Austin, TX
Tulsa Octoberfest	October 19-22	Tulsa, OK
Small Steps Golf Classic	October 30	Houston, TX

*Denotes an Opportune Sponsored Event

ABOUT RALPH E. DAVIS ASSOCIATES

Ralph E. Davis Associates LLC (RED) is an industry-leading petroleum engineering and geosciences firm committed to satisfying the individual needs of clients. We accomplish this by holding ourselves to the highest standards of integrity and professionalism to deliver honest, direct and actionable insights to help clients achieve their strategic objectives. We distinguish ourselves by combining reservoir engineering, geoscience evaluation techniques and advanced data analytics with economic analyses to provide our clients with individual, customized solutions.

Banks, bondholders, private equity firms, financial institutions and law firms around the world trust in RED's diverse services and unrivaled upstream oil and gas expertise to deliver comprehensive solutions that help clients make informed decisions. We add value to every engagement by employing a team approach, leveraging Opportune LLP's experienced bench of experts in transactional due diligence, tax advisory, investment banking, restructuring and valuation.

We offer technical and economic analyses to deliver our clients a complete, independent, accurate and detailed assessment of the value of their assets. We apply a robust set of technical capabilities to assist our clients. Our capabilities include:

- Reservoir engineering and geosciences
- Economic forecasting and reporting
- Data analytics and geospatial analysis

KEY CONTACTS

Steve Hendrickson is the President of Ralph E. Davis Associates, an Opportune LLP company. Steve has over 35 years of professional leadership experience in the energy industry with a proven track record of adding value through acquisitions, development and operations. Steve is a licensed professional engineer in the state of Texas, and holds an M.S. in Finance from the University of Houston and a B.S. in Chemical Engineering from The University of Texas at Austin. He recently served as a board member of the Society of Petroleum Evaluation Engineers (SPEE) and is a registered FINRA representative.

John Beaird is Vice President of Ralph E. Davis Associates, an Opportune LLP company. John has 39 years of oil and gas management, reservoir engineering, and petroleum economics evaluation experience. Recent relevant experience includes the Permian, Western Gulf, Tx-La-Miss Salt, Mid-Continent, Denver-Julesburg, Wind River, Williston Basin, and Appalachian Basins. John is a registered Petroleum Engineer in the State of Texas and holds a B.S. in Petroleum Engineering from Louisiana Tech University. He is also an active member of the Society of Petroleum Evaluation Engineers (SPEE).

Yvonne Trujillo is a Senior Petroleum Engineer at Ralph E. Davis Associates, an Opportune LLP company. Yvonne has over 25 years experience in the oil and gas industry with extensive expertise in reserves engineering, SEC and PRMS/SPE reporting and economics and asset evaluation in conventional and unconventional reservoirs in the U.S. Lower 48. Yvonne earned a B.S. in Mechanical Engineering at Simon Bolivar University in Caracas, Venezuela and an M.S. in Petroleum Engineering at the University of Houston.

David Edwards is a Petroleum Engineer at Ralph E. Davis Associates, an Opportune LLP company. David has over three years of reserves engineering experience in conventional and unconventional reservoirs. Before RED, David was a Petroleum Engineer at a lower middle market A&D advisory firm where he handled the technical processes for marketed assets. He began his career with an operator in Dallas, where he contributed to its engineering, operations, and A&D teams. David holds an M.B.A. from The University of Texas Permian Basin and a B.S. in Petroleum Engineering from The University of Oklahoma.