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# Eagle Ford Shale

*The 2011 Playbook*



A supplement to

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## Eagle Ford: The Playbook

A supplement to *Oil and Gas Investor, E&P,*  
and *Midstream Business*

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The Eagle Ford Shale Playbook is the twelfth in Hart Energy's exclusive series of comprehensive reports delving into North America's most compelling unconventional resource plays. Our lineup of topics addresses the plays everyone is talking about and delivers answers to essential questions on reservoirs, active operators, economics, key technologies, and infrastructure issues. Each playbook features a full-color map highlighting fields, drilling activity, and significant wells. To learn more, visit [www.ugcenter.com/subscribe](http://www.ugcenter.com/subscribe)

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On the cover: A Newfield rig in South Texas works the Eagle Ford Shale on approximately 335,000 acres controlled by the company. (Photo courtesy of Newfield Exploration Co.)



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Thirsty for liquids, producers from near and far are staking a claim in South Texas' Eagle Ford Shale. (Photo by Lowell Georgia)

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# Eagle Ford: Act 2

Fortunes are being made in South Texas' Eagle Ford Shale play whose founder, Petrohawk Energy Corp., has already exited to an international integrated for a 69% premium.

**By Nissa Darbonne**  
Contributing Editor

**C**NOOC Ltd., Marathon Oil Corp., BHP Billiton Ltd., Mitsui & Co. Ltd. They all want in.

The South Texas Eagle Ford shale-gas and -oil basin is changing the US energy-resource profile on a world scale. Rehan Rashid, managing director and group head, energy and natural resources research for FRB Capital Markets, estimates the play is worth at least US \$85 billion to operators and as much as \$200 billion as best practices in tapping the formation improve.

Top acreage-holders are independent E&Ps who were early to the shale: EOG Resources Inc., Apache Corp., Chesapeake Energy Corp., and Petrohawk Energy Corp. It is noteworthy that some of the smallest producers represented in the play are among the world's largest companies, such as ExxonMobil Corp. and BP Plc.

The asset grab to get into the reservoir has set off heated M&A deal-making, with Marathon stepping up with \$3.5 billion in cash to bolt on privately held Hilcorp Resources Holdings LP's 141,000 net acres to its existing profile and with the previously unrepresented BHP stepping up with \$15.1 billion in cash to buy out Petrohawk. The price for Petrohawk's 3.4 Tcfe of proved reserves across mostly two plays — the Haynesville and the Eagle Ford — is nearly 40% that of ExxonMobil Corp.'s \$41 billion purchase price in 2010 for XTO Energy Inc.'s 13.9 Tcfe of proved reserves across more than a dozen plays.

For Petrohawk, the exit, which was scheduled to close by the end of this quarter, is at \$18,700 per flowing Mcfe and \$4.45 per Mcfe of proved reserves.

Petrohawk discovered the play in the second half of 2008, naming its first field Hawkville. Bob Brack-

ett, senior analyst for Bernstein Research, said the deal with BHP reinforces his and fellow research-team members' view that the US industry is in the second stage of an "'unconventional manifest destiny,' where a change of (operator) focus towards liquids and potential theme of consolidation play out."

Top wells reported from the Eagle Ford to date include privately held Enduring Resources LLC's #1 Keach Gas Unit in DeWitt County, making 1,010 bbl of condensate and 15.8 MMcf of gas its first day, and the Karnes County blockbuster, Pioneer Natural Resources Co.'s #1 Handy, that came in at some 20 MMcf per day. A prolific condensate-maker, ConocoPhillips' #2 Butler A-304 in La Salle County came in at 1,348 of liquids its first day, plus 7.5 MMcf of dry gas.

And, with well costs of between \$6.5 million and \$10 million for most operators, the play isn't for the kind of hole that makes 253 bbl in its 24-hour initial-production (IP) test, which is what one producer reported from Dimmit County this summer. It was flatly deemed disappointing by both the operator and securities analysts.

## The numbers

Rashid's \$85 billion estimate for the Eagle Ford's worth is the base case and it's likely to change to his \$200 billion estimate, which is the high case, in time. The low-case number is based on current first-30-day production rates and estimated ultimate recovery (EUR) per well; the high case, on whether improvement in tapping the resources is similar to advancements shown in the Barnett and the Fayetteville plays as producers have worked those over the years.

**Single-Well IRR v. Oil Price\***

<b>Play/Window</b>	<b>\$60</b>	<b>\$70</b>	<b>\$80</b>	<b>\$90</b>	<b>\$100</b>	<b>\$110</b>	<b>\$120</b>	<b>\$130</b>	<b>\$140</b>
Barnett/Liquids	36.2%	49.4%	65.4%	84.7%	107.8%	135.6%	169.0%	209.2%	257.8%
Barnett/Gas	22.4%	23.8%	25.3%	26.7%	28.3%	29.8%	31.5%	33.1%	34.8%
Marcellus/Liquids	67.2%	71.8%	76.5%	81.5%	86.7%	92.2%	98.0%	104.0%	110.3%
Marcellus/Gas	67.2%	67.2%	67.2%	67.2%	67.2%	67.2%	67.2%	67.2%	67.2%
Eagle Ford/Liquids***	46.4%	62.2%	81.1%	103.8%	131.0%	163.6%	202.5%	249.3%	305.6%
Eagle Ford/Gas	25.8%	25.8%	25.8%	25.8%	25.8%	25.8%	25.8%	25.8%	25.8%
<b>Single-Well IRR v. Gas Price**</b>	<b>\$3.00</b>	<b>\$3.50</b>	<b>\$4.00</b>	<b>\$4.50</b>	<b>\$5.00</b>	<b>\$5.50</b>	<b>\$6.00</b>	<b>\$6.50</b>	<b>\$7.00</b>
Barnett/Liquids	39.9%	44.3%	49.1%	54.2%	59.7%	65.4%	71.6%	78.2%	85.2%
Barnett/Gas	4.2%	7.6%	11.2%	15.4%	20.0%	25.3%	31.1%	37.6%	44.8%
Marcellus/Liquids	16.2%	24.1%	33.8%	45.5%	59.7%	76.5%	96.7%	120.6%	149.3%
Marcellus/Gas	7.5%	14.5%	23.6%	35.1%	49.4%	67.2%	89.1%	116.1%	149.3%
Eagle Ford/Liquids**	40.4%	47.2%	54.5%	62.6%	71.5%	81.1%	91.7%	103.2%	115.7%
Eagle Ford/Gas	(1.0%)	0.6%	4.9%	10.3%	17.2%	25.8%	36.5%	49.4%	64.8%

\* Oil price at constant \$80/bbl. \*\* Gas price at constant \$4.50 MMBtu. \*\*\* Excludes condensate or natural gasoline.

Source: FBR Capital Markets

As crude oil prices grow, the profit from gas-liquids-rich plays improves; however, the price of the dry gas or methane is unchanged. Meanwhile, profit from gas-liquids-rich plays improves as dry gas prices improve as well, meaning the liquids are a bonus no matter the oil or gas price market.

“We believe that the market continues to not appreciate the statistical and predictable nature of the learning curve,” Rashid said. “Our analysis indicates that every doubling of cumulative wells drilled in other shale plays has yielded a 15% to 23% improvement in productivity as measured by increases in the average 30-day production rate.”

In the Barnett, each time the number of wells drilled has doubled in the past, the average first-30-day IP has improved 17.5%, he said. In the Fayetteville, the improvement was 23.1% each time; the Bakken, 15.6%; and the Haynesville, 15%.

At the current pace of drilling the Eagle Ford, with 140 rigs at work, he forecasted the well count will double every 12 to 15 months. Rashid then compared the outlook for the Eagle Ford to what has been demonstrated in the Bakken, which is also oil-rich and where the flow of oil is more complicated than that of gas, which is a smaller molecule.

“Assuming that the Eagle Ford learning curve follows the same 15.6% path as the Bakken and taking into account the current and forecasted rig count, we would expect the 30-day average IP rates in the oil window to increase to 850 boe/d by the fourth quarter of 2012 and to 1,100 by the end of 2015,” he said. This would be improved from the average 585 boe/d that was posted at year-end 2010.

IP rates in the wet gas window that averaged 6 MMcf/d at year-end 2010 would improve to 10.5 MMcf/d by year-end 2015, Rashid added.

To reach these targets, advances in completion technologies and processes will be critical. Producing gas shales to give up economic amounts of resource has largely depended on “contact progression” — that is, lateral length, number of frac stages, and perforations per stage, he said. In liquids-rich shales, a greater emphasis is needed on

**Top Eagle Ford Net-Acreage-Holders\***

EOG Resources Inc.	590,000
Apache Corp.	450,000
Chesapeake Energy Corp.	430,000
Petrohawk Energy Corp.	350,000
Newfield Exploration Co.	300,000
Marathon Oil Corp.	285,000
Royal Dutch Shell	250,000
ConocoPhillips Co.	240,000
Murphy Oil Corp.	200,000
SM Energy Co.	200,000
Anadarko Petroleum Corp.	170,000
Pioneer Natural Resources Co.	150,000
El Paso Corp.	150,000
Forest Oil Corp.	105,000
Swift Energy Co.	80,000
Talisman Energy Inc.	78,000
Hess Corp.	75,000
Statoil ASA	70,000
Rosetta Resources Inc.	65,000
Plains E&P Co.	60,000
Geosouthern Energy Corp.	50,000
ExxonMobil Corp.	50,000
Cabot Oil & Gas Corp.	50,000
Goodrich Petroleum Corp.	40,000
BP Plc	40,000

\* Including net of JVs. Source: Bernstein Research, July 15, 2011

In terms of net acreage, which excludes operators' acreage that is held in joint ventures, EOG Resources Inc. has the No. 1 position. Notably, supermajors ExxonMobil Corp. and BP Plc are among the last in the play.

"conductivity" — that is, proppant type and size and specialized fracture-stimulation techniques. "Progression in conductivity technologies and processes will be the most important part of improvements in liquid IP rates," Rashid said.

Nevertheless, even under his base-case scenario, the Eagle Ford would be a leading US producer by 2015, making 800,000 bbl of oil and condensate per day. But, in his high-case scenario, which assumes capture of 12% of the rock's oil and 30% of its condensate, it could be among the top five US onshore producers at a whopping 1.5 million per day.

London-based Evaluate Energy Ltd. estimates, based on analysis of new drilling data, "the Eagle Ford may soon become the biggest producing shale play in Texas, and possibly the whole of the United States."

The formation, which lies beneath 24 South Texas counties, was giving up 66,000 boe/d at year-end 2010 with only two years of producer attention and while most of that time — second-half 2008 through 2009 — producers were undergoing capital-access and declining-commodity-price duress.

Evaluate Energy expects the Eagle Ford bounty to surpass that of the mother US shale play, the Barnett, which was making 877,000 boe/d at year-end 2010, and the Haynesville, which was putting out 708,000. "The Haynesville play rose from low levels of production in early 2007 to match the Barnett volume within four years," Evaluate Energy reported. "What's more, the amount of new wells being drilled in Eagle Ford counties is growing at a much faster rate than the Haynesville ever did in the four-year period."

A significant factor in aggressive drilling of the Eagle Ford is that it is liquids-prolific when liquids are worth as much as \$100 a barrel, the firm noted, while the Barnett and the Haynesville primarily give up dry gas that has gone to market at between \$4 and \$5 an Mcf in the past year.

### E&Ps in position

Rashid says 7.5 million acres could be in play over Eagle Ford with 3 million in the black oil window, 1.5 million in the volatile oil or high-condensate window, 1.5 million in the low-condensate or gas liquids window, and the remaining 1.5 million in the dry gas window.

Bernstein Research's Brackett named EOG Resources Inc. as having the industry-leading position in the Eagle Ford, with 590,000 net acres in the play and more than 80% of this in the high-liquids



## Data & Consulting Services

Our Consulting Services geoscientists and engineers know every play—including the Eagle Ford. We have unmatched experience in unconventional shale plays. When one operator's staff lacked the time, expertise, and tools to evaluate its Eagle Ford leases, our consultants

**Schlumberger**

region of the play. It is nearly tied with Chesapeake Energy Corp.'s gross leasehold and its percentage in the liquids window, when including Chesapeake acreage that is in a joint venture with CNOOC.

### Marathon/Hilcorp Implied Transaction Multiples

Purchase Price		\$3.5B
Net Acre	141,000 Net	\$24,823
Net Acre (Adjusted)*	141,000 Net	\$19,858
Net Risked Resource Potential (\$/BOE)	450 MMBOE	\$7.78
YE 2011E Proved Reserves (\$/BOE)	100 MMBOE	\$35
YE 2011E Production (\$/BOE/d)	12,000 BOE/d	\$291,667
Peak Production (2016E) (\$/BOE/d)	80,000 BOE/d	\$43,750

\* Adjusted to remove value for current production valued at \$100,000 per BOE/d (\$700 million). Source: Barclays Capital

Within a year, Hilcorp Energy and financial partner KKR flipped a \$1 billion venture in the Eagle Ford to Marathon Oil Corp. for \$3.5 billion.

"In addition, EOG built its position deliberately and early, so it has both quantity and quality," Brackett said. "To oversimplify, there are four zones in the Eagle Ford: dry gas, wet gas, gassy oil, and low-volatility oil. Of the zones, the gassy oil zone is the most prospective in that it yields high liquids — so high revenue — at high rates, supported by the dynamics of gas-rich oil."

EOG has virtually written the book on the rock, publishing what Brackett called "almost a dummy's guide for the Eagle Ford" in April 2010. "Companies that acquired acreage after that point found themselves late to the game, acquiring lower-quality positions at higher costs and higher royalties. EOG was bold enough to publish such details because of its confidence in its position that it had built," he said.

Forecasted first-month revenue from EOG's Eagle Ford wells is \$1.84 million per well, No. 2 only to privately held 50,000-net-acre-holder Geosouthern Energy Corp.'s \$2.68 million. Brackett bases this on \$100 oil and \$4.50 gas. "We note also

## Magnum Hunter

Magnum Hunter Resources Corp. CEO Gary Evans told investors at IPAA's OGIS New York conference recently, "One of the things we're striving to do in the Eagle Ford is to go out further."

With seven wells completed and producing in the play, the company has upsized from 4,000-ft laterals to its most recent of 6,000 ft, although 800 ft were lost at the toe due to mechanical problems. "We're fracing more stages, too," he said. "We're trying to get up to 20 stages per well." Most Magnum Hunter wells to date were completed with 14 to 16 frac stages. The company holds 25,000 net acres play-wide, most in joint ventures with Hunt Oil Co., EOG Resources Inc., and Geosouthern Energy Corp. Most of its acreage is concentrated in the oil window of Gonzalez County, with some in Fayette, Lee, and Atascosa counties.

Its latest wells drilled have averaged 1,200 to 1,300 boe/d. "Our goal is to get to 2,000 boe/d per well IP (initial production)," Evans said. Current wells are typically leveling out at 400 to 600 bbl per day. Production is 98% oil, "not condensate," he clarified.

Neal Dingmann, E&P analyst for SunTrust Robinson Humphrey, said Magnum Hunter's Eagle Ford position has tremendous upside. "With recent well results in the area surpassing 1,000 boe per day, we believe huge upcoming growth for Magnum should be expected in the play. Being largely in the oil window should help ensure that well economics remain high going forward."

Well costs are near \$8.2 million at present, but Evans is determined to drive costs down. The company buys a lot of its own equipment, from lighting to frac tanks to well agitators. "The last well we drilled was \$7.5 million; our goal is to get to \$7.2 million," Evans said.

Magnum Hunter runs high-case and low-case economics. Based on a 1,280 bbl/d model with 500,000 boe estimated ultimate recovery (EUR), the internal rate of return (IRR) is 36% at \$80 oil and 64% at \$100. Modeling 613 bbl/d and 362,000 boe EUR, a low case, IRR is 23% at \$80 and 39% at \$100. ■



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## Rosetta Resources

Our Eagle Ford assets continue to outperform our expectations. So said Rosetta Resources Inc. Chief Executive and President Randy Limbacher, summing up first-quarter 2011 on a conference call with investors and analysts.

Rosetta holds 65,000 total acres in the Eagle Ford play, but it has focused its attention heretofore on its 26,500-acre Gates Ranch prospect in northern Webb County. During the first quarter, Rosetta drilled nine wells here, and had production of 120 MMcf/d, up from zero 18 months prior. "Impressive," stated Wunderlich Securities analyst Irene Haas.

The company has begun three-well pad development, resulting in a cost savings of \$500,000 per well. "Rosetta continues to optimize drilling and completion operations which have offset service-cost inflation," said Michael Bodino, managing director and head of energy research for Global Hunter Securities. "Spud-to-release has decreased during the past 15 months from 27 days to 15, and pad development allows the rig to mobilize in hours rather than the previous five to seven days."

Bolstered by recent asset sales and \$385 million in liquidity, Rosetta has added a third rig to its program to test acreage beyond the Gates Ranch, specifically 25,000 acres in the liquids windows in southern Gonzalez, central Dimmitt, northern La Salle, and Encinal counties. It plans to have 58 horizontal wells drilled and completed by year-end.

But with the ramp-up comes challenges. Even with firm takeaway commitments in hand, Limbacher said he continues to closely watch the midstream infrastructure situation carefully. "Two potential pressure points are trucking capacity and the reliability of firm gas transportation," he alerted.

Oil hauling in South Texas is extremely tight and will continue to be for some time, he said. The company has sufficient trucking capacity now, but is moving toward other solutions such as rail, additional pipe, and barges.

Gas takeaway is challenged as well, even with firm commitments for existing production. "We've seen our midstream partners struggling from time to time to provide firm capacity for which we've contracted," he said. Rosetta has moved gas to other carriers on a short-term basis. "Expect us to continue to develop additional takeaway options to ensure plenty of gas-pipeline capacity for our key projects in the future." ■

that EOG is not attempting to drill and complete wells to ensure high rate; they are actually more methodical about their development plan.

"If anything, EOG could boost its reported rates if it were interested in headlines over development plans," he added.

Highly profitable wells have become more common than uncommon from the reservoir in its fewer than three years of being tapped. Swift Energy Co., which holds a legacy position in South Texas, completed its 5,660-lateral-length SMR EF 2H earlier this year with a 16-stage frac for a first-24-hour IP of 1,080 bbl of oil and 600,000 Mcf of gas. Forest Oil Corp. made four horizontal, oily wells this spring for 24-hour IPs averaging 747 boe. GeoResources Inc.'s first two operated wells, Flatonia East Unit #1 and #2, had first-24-hour IPs of 1,274 and 1,322 boe; the wells averaged 487 and 495 boe a day during the subsequent two weeks of production.

Hess Corp., which has grown its position in Eagle Ford to 107,000 net acres, had three wells online in

late July; its average 30-day IP was some 650 boe per day, 80% liquids. The company's newer wells will undergo between 15 and 21 frac stages and cost about \$10 million each. "It's still early days, (but) the initial results from the wells drilled in the Eagle Ford are encouraging..." said Greg Hill, Hess executive vice president and president, worldwide E&P. "We expect cost to come down with time because, again, we're early in the learning curve."

A Crimson Exploration Inc. well, Littlepage McBride #1H in Karnes County, was making 525 boe/d in July and had given up a total 53,000 boe since coming online in early April. Results of the longtime South Texas operator's first Eagle Ford well in Zavala County, KM Ranch #1H with a 5,800-ft lateral and 20-stage frac, were anticipated in mid-August.

And, Abraxas Petroleum Corp., also a legacy operator over the rock, has made headlines in its Blue Eagle LLC joint venture with Rock Oil Co. LLC. The partners' T-Bird 1H in DeWitt County IP'ed

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### 2011 Eagle Ford Transactions, Plus Selected \$1B-Plus Deals

Date Announced	Buyer	Seller	Transaction Value (\$MM)	Net Acres	\$/Net Acre
6-30-11	Undisclosed	Forest Oil Corp.	\$110	10,000	\$11,000
6-29-11	Mitsui & Co. Ltd.	SM Energy Co.	\$735	39,000	\$17,403
6-20-11	JGC Energy Development	Tritech I LLC	\$65	6,300	\$10,317
6-13-11	Statoil ASA, Talisman Energy	SM Energy Co.	\$225	15,400	\$14,610
6-1-11	Marathon Oil Corp.	Hilcorp Energy Co.	\$3,500	141,000	\$24,823
3-21-11	KNOC	Anadarko Petroleum	\$1,550	96,000	\$16,146
10-10-10	Talisman/Statoil	Enduring Resources	\$1,325	97,000	\$10,900
10-10-10	CNOOC Ltd.	Chesapeake Energy	\$2,160	200,000	\$10,800
3-28-10	Royal Dutch Shell	Harrison Ranch	\$1,000	95,300	\$12,015
6-24-10	Reliance Industries	Pioneer Natural Resources	\$1,145	100,000	\$10,000
<b>Median, All Deals, Beginning 1-14-10</b>			\$180	35,000	\$9,865

Source: Tudor, Pickering, Holt & Co. Securities Inc.

Marathon Oil Corp.'s purchase of Hilcorp's Eagle Ford position holds the high-water mark for transactions in the play. BHP Billiton Ltd.'s \$15.1 billion bid for Petrohawk Energy Corp. approaches it; however, the deal includes Haynesville Shale gas and Permian Basin acreage as well as Eagle Ford.

1,515 boe in February; in July, it was putting out some 1,100 boe per day, 50% condensate and gas liquids. Irene Haas, senior vice president and senior equity analyst for Wunderlich Securities Inc., noted that T-Bird 1H made some 200,000 boe in its first 150 days online. "The well is performing better than the 1.1 million boe (EUR) type curve," she said.

Another Blue Eagle well — Matejek Gas Unit 1, this one operated by Talisman Energy Inc. in DeWitt County — had a 3,600-ft lateral and underwent a 14-stage frac. It flow tested at restricted rates its first 24 hours in excess of 780 boe, she added.

#### Spacing and EUR

FBR's Rashid noted, citing EOG's guide to the shale play that Brackett also references, that most of the oil generated by Eagle Ford source rock stayed in the source rock — very much like the case in the Bakken liquids-rich play — as opposed to typical expulsion of 95% of hydrocarbons generated. The reservoir is

generally overpressured, which helps recovery, and its strong porosity means the resource is well stored, he added.

"Micro-seismic indicates good fracture complexity (of the rock). Matrix contribution has generally been found to be extensive — as high as 90%, according to EOG. As such, the industry has continued to witness hyperbolic, rather than exponential, decline curves..., which bodes well for ultimate per-well EURs," Rashid said.

In EOG's northeastern and central acreage in the oil window, its wells are making 24-hour IPs of between 800 and 1,500 bbl; in the southwest, 600 to 800, he said. Goodrich Petroleum Corp., in the oil window north of EOG where the formation is shallower and lower-pressured, is reporting IPs of between 500 and 1,000 bbl.

Rashid's base-case estimate for surfacing Eagle Ford resources assumes 4% recovery in the oil window and 13% in the wet gas window; his high-case model



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## SM Energy

Holding 250,000 net acres in the Eagle Ford Shale, SM Energy Co. President and CEO Tony Best told investors at IPAA's OGIS New York conference, "This is a company-maker for SM Energy. It's a great position."

SM holds 165,000 net, 100%-operated acres, mostly in the rich-gas window in Webb and La Salle counties. Here, the company is working three rigs at present and plans to gear up to six by year-end. The company also holds a 25% nonoperated position of 85,000 net acres with Anadarko Petroleum Corp. in Maverick and Dimmitt counties with 10 rigs running.

Foremost on Best's mind was takeaway capacity, and he wanted to assure that the company is in good position to handle its increasing production. "We've been able to secure significant takeaway capacity, and we've contracted for the drilling and completion services that we're going to need for this year and next. That is going to be critical in our ability to ramp up in the program," he said.

SM now has takeaway commitments for 150 MMcf/d through mid-year, going to 300 MMcf/d by the end of 2012. It has also secured a new takeaway agreement for an additional 190 MMcf/d when a pipeline arrives in 2013. "By mid-2014 we will have 470 MMcf/d of takeaway capacity to accommodate our program in this play," Best said.

Comparing with total company-wide production for 2010, Best said, "That is clear evidence of the significant impact the Eagle Ford can have on SM Energy and the opportunity we see in front of us in this play. It's a pretty exciting time for us."

Analysts at Tudor, Pickering, Holt & Co. agree. "Our review of a handful of wells that have flowed without constraint in the Galvin Ranch area shows productivity as good as offset operators," with 1.1 Bcfe of cumulative production in the first six months, they noted. "The implication is as incremental infrastructure comes online, SM should be able to quickly fill the pipe." ■

assumes 12% in the oil window and 33% in the wet window. "The gas charge is significant in the volatile oil window, allowing for a better sweep of the reservoirs. Ultimate EURs will materially benefit from high gas content/depletion drive. We note that a conventional reservoir with a similar gas sweep would have recovered 40% to 50% of in-place resources."

Wunderlich's Haas says down-spacing is on the horizon. "The (Blue Eagle) JV has 60 net drillable locations using 160-acre spacing; per-well EUR is 500,000 boe, with average drilling and completion costs of \$8.5 million," she said.

"In our opinion, the JV could potentially double its drillable locations, if we were to assume tighter spacing in the 50- to 80-acre range. Some Eagle Ford producers are testing for optimal well spacing."

Rosetta Resources Inc., which has some 65,000 net Eagle Ford acres, is outpacing the type curve on its Gates Ranch lease, said Jack Aydin, senior managing director and equity research analyst for KeyBanc Capital Markets Inc. "Our best guess is that EURs could be north of 8.5 Bcfe per well on average in the area versus Rosetta's previous type curve of 7.2 Bcfe."

Rosetta's 5,000-ft-lateral wells cost some \$8 million and undergo 15 to 17 frac stages, using designer

proppant. On 100-acre spacing, it estimates it is recovering less than 20% of the resource in place. Results may be available later this year from testing drainage down to as low as 50 acres, Aydin said.

"Stay tuned, as 50-acre spacing could double the company's inventory and resource potential in the play. Including 50- and 60-acre infill drilling, Rosetta estimates it could have 441 net wells to be developed at Gates Ranch and, based on a conservative 7.2 Bcfe EUR, the company could have nearly 3.2 Tcfe of resource potential with very little exploration risk," he said.

FBR's Rashid noted that a great deal of Eagle Ford rock is under large, single-owner lease tracts, such as Gates Ranch, and that the Texas Railroad Commission, which permits wells in the state, has "not had an issue so far with the ever-increasing lateral length."

Anadarko Petroleum Corp. is planning to test 50-acre spacing and 9,000-ft laterals in the wet window, he said. "Rosetta seems optimistic about 50- to 100-acre spacing, and Marathon is planning to test 80-acre spacing sometime this year. Petrohawk notes that, in its Hawkville (Field), it is already comfortable with 90-acre spacing, and it has comfort with 100-acre spacing in (its) Black Hawk area," Rashid said.



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In the oil window, Goodrich was drilling a 9,000-ft lateral this summer in the oily window. In Petrohawk's Hawkville Field, its longest lateral has been 7,200 ft with 23 frac stages; in its Black Hawk Field, 6,200 ft with 21 stages. "Hawkville stage lengths have been about 300 ft with about 52-ft, perforation-cluster spacing," he added.

Now, the play's founder is experimenting with shorter stage lengths — about 200 ft — in its Black Hawk area and perforation-cluster spacing of some 30 to 35 ft.

### Service costs

With some 140 rigs at work in the play, service costs are bulging and availability is constrained. Newfield Exploration Co. Chairman, President and Chief Executive Officer Lee Boothby said, "Frankly, we've seen a blowout in the service cost, particularly in the pressure-pumping side of the equation. And I hate to use this phrase, but it's margin destruction."

To combat that, the company is running a curtailed drilling program, focusing on data it develops from each well and applying it to the next; its acreage is not at risk of being forfeited to lease expiration. "We're not going to accelerate activity in the Eagle Ford because we don't have to," Boothby said. "So we're going to execute a slow-go strategy there and we'll be ready to ramp up when the time comes that those margins compete with other parts of the (company's) portfolio."

Newfield Executive Vice President and COO Gary Packer said operating expenses in the play have grown — not just drilling and completion. "I'd say water handling has been probably the single biggest area that we've seen increases in. But just anything from human resources on has gotten more expensive throughout the business. Chemicals, everything is higher than what it once was."

Newfield, which holds 335,000 net acres in the Maverick Basin that also contains targets for production from Pearsall and Georgetown, has a

## Carrizo Oil & Gas

With 33,000 net acres in the condensate window of La Salle and Dimmitt counties, Carrizo Oil & Gas Inc. President and Chief Executive Chip Johnson said at IPAA's OGIS New York conference, "Most people think this will have the best economics of any area of the Eagle Ford. It's extremely profitable."

The company is looking to expand its position through lease acquisitions, focusing in Dimmitt, northern La Salle, McMullen, and Atascosa counties. The goal: to target the play where shallower than 10,000 ft, with some condensate but with a majority stream of oil production. "It's very hard to find more acreage here now at a reasonable price."

Nonetheless, in early June, Carrizo bolstered its position with 13,000 new acres for \$1,650 per acre upfront, and a total cost of approximately \$5,500 per acre once carried drilling costs are factored. While a reasonable price in comparison with other recent acquisitions, Jefferies & Co. Inc. E&P analyst Subash Chandra noted, "Those transactions largely included more production, more delineation, greater infrastructure as well as higher EUR targets."

Carrizo's first three Eagle Ford wells IP'ed at more than 1,000 bbl of oil each on a 24-hour rate. The following two came in at 735 and 815 bbl at restricted rates. Average EURs with well expectations of 70% liquids and 30% rich gas are 400,000 boe, with total target reserves of 92 million boe.

Total well costs are \$7 to \$7.5 million with 5,000-ft laterals and 18 frac stages, drilled into the condensate window above 10,000 ft. Finding and developing costs average \$23.33 per well, with a 54% rate of return at \$100 oil and \$4 gas.

Subsequent to the acquisition, Carrizo now runs three rigs in the Eagle Ford, up from one at the time Johnson spoke. The company borrowed one rig from its Barnett Shale program, which is saturated with wells waiting on completion, to target Dimmitt County. That rig will return when a purpose-built Eagle Ford rig is delivered in December. The ramp-up coincides with a \$104 million divestiture of non-core Barnett properties.

The company anticipated completing three wells a month through the end of the year, beginning in June. It now estimates it has 230 locations on 115-acre spacing. ■

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pilot program under way using pad drilling to determine optimal well spacing. The company is drilling its wells in as few as seven days and costs are averaging some \$6.6 million. Initial 24-hour IPs from recent wells have ranged from 400 to 1,400 boe.

The company is trying spacing pilots and various completion techniques. “That’s part of why you see the wide range,” said John Jasek, Newfield vice president, onshore Gulf Coast.

Anadarko Chairman and CEO Jim Hackett said the company’s past 20 Eagle Ford wells were each drilled in fewer than 10 days. It added first production from 33 wells in the second quarter and has 11 rigs at work. The company, which has some 400,000 gross acres in the play, was making 45,000 boe per day from it at the end of June, compared with 36,000 at the end of March.

Many Eagle Ford operators are waiting for fracture-stimulation crews to complete their wells. Frac operator Halliburton Co. Chairman, President and CEO Dave Lesar said frac-crew supply in the US “is basically a tale of two cities. Any of the liquids plays — be it the Bakken, the Eagle Ford, the liquids (window of) the Marcellus — they all continue to be undersupplied and, in some cases, undersupplied dramatically from a fracturing market.”

Dry gas plays are probably sufficiently served, he said, but “the oil basins or liquids basins, they all continue to be underserved...We are not going to leave equipment in a market that doesn’t give us the kind of returns we want. So we will search for that (profit) model with a specific subset of customers. And if we get there, we’ll stay (such as in the dry-gas Haynesville). But if we don’t get there, we will go to the liquids-rich plays.”

FBR’s Rashid said there isn’t good news in the near future. “We assume frac capacity (in the Eagle Ford) to remain tight for quite some time to come. Of course, significant additional capacity for the whole industry is on the way, but, given the level of activity everywhere, it is hard to assume any reasonable softening in rates at this point.”

### Companies in play

Canaccord Genuity energy analyst John Gerdes noted that BHP’s \$15.1 billion bid for Petrohawk

is roughly 60% for the company’s Eagle Ford Shale exposure and approximately 40% for its Haynesville production and future potential. “Given that the majority of the value unlock appears to lie in the Eagle Ford, we believe all names exposed to the play are likely to perform well on the news, specifically EOG and Goodrich,” he said.

Don’t stop there. KeyBanc’s Aydin adds Pioneer Natural Resources, Rosetta, SM Energy Co., and Newfield. He estimated Petrohawk shareholders will be paid \$4.45 per proved Mcfe when the deal is closed, while companies in its peer group were trading at \$2.50 per proved Mcfe; in terms of dollars per net acre, the BHB bid is \$15,100.

Subash Chandra, managing director and energy analyst for Jefferies & Co. Inc., said BHP is in a unique situation. “They are looking for undercapitalized entities with large, de-risked resource potential that can be accelerated by a larger balance sheet. More importantly they are gas bulls. That much was clear when they paid top dollar for Chesapeake’s Fayetteville assets (earlier this year).”

BHP plans to spend twice as much on drilling as Petrohawk — totaling \$5 billion in 2015 and \$7 billion in 2020. “Every oilfield-service analyst in the US will rejoice,” Chandra said. “But we can’t fathom how this level of spending will fix the gas glut.”

Jeff Dietert, Simmons & Co. International managing director and co-head of research, also pointed to BHP’s distinct vantage point. “A sophisticated buyer with extensive knowledge of global commodity markets is paying cash to acquire North American unconventional gas and liquids assets. Keep in mind that BHP likely has the most insightful view of any non-Chinese company on long-term Chinese energy and mineral demand.”

He also sees the buy-in as a signal of the maturation of US unconventional resource plays: The entrepreneurial phase is waning. “It will gradually be replaced by a new phase signified by larger organizations with lower costs of capital that are ultimately better suited to develop the resources.” ■ Company profiles by Steve Toon, Senior Editor, *Oil and Gas Investor*.



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# Industry Accelerates Eagle Ford Campaign

Operators emerge from opening moves to full-scale operations.

**By Don Lyle**  
Contributing Editor

Large companies solidified and increased property positions, smaller companies took profits from property sales, and nearly everyone profited from association with the South Texas Eagle Ford Shale play.

The play has grown considerably since Hart Energy published the first Eagle Ford Playbook only a year ago.

According to El Paso Corp., all sources of US unconventional gas provided 57.7 Bcf/d of gas in 2010 and will contribute 74 Bcf/d in 2020. In parallel, South Texas produced 4.4 Bcf/d in 2010 and should contribute 7.8 Bcf/d in 2020, or more than 10% of the total. The Eagle Ford and Pearsall shales will play a major part in that production.

Pioneer Natural Resources Co. placed the gross resource potential of the play at 150 Tcfe/d of gas.

That's a good reason for some US \$10 billion in sales and acquisitions in the play between June 2010 and June 2011, including Hilcorp's \$3.5 billion sale of Eagle Ford properties to Marathon Oil Corp., Chesapeake Energy Co.'s \$2.2 billion deal with China's CNOOC, Anadarko Petroleum Corp.'s \$1.5 billion venture with Korea's KNOC, Talisman's joint venture with Statoil, and Royal Dutch Shell's rising property position.

Those companies, and others, aren't just sitting on their land. According to Lucas Energy, 99 rigs worked the Eagle Ford in 2011, up from 15 compared to 2009. That was more rigs than were working the Barnett Shale in the first month of 2011.

Pioneer Natural Resources said 125 rigs worked the Eagle Ford in June 2011, and Halliburton expected the rig count to reach 200 by the end of the year.

Permitting in South Texas supports the higher rig count. According to Magnum Hunter Resources Corp. more than 1,030 wells had been permitted or drilled in the Eagle Ford Shale in 20 counties by June 2011. Permits set a monthly record at 209 in December 2010, up from 132 in the same month in 2009.

Marathon calculated the extent of the play in South Texas at 130 by 50 miles, or about 230 million acres, but the Eagle Ford may expand beyond that area.

Rippy Oil Co. established the Aguila Vado Field in Leon County in East Texas as an Eagle Ford producer in early 2010 based on its Simms No. 3H discovery. That field covers an interval from 6,390 to 7,180 ft, and the company asked for 160-acre oil spacing units.

The company's 2H Easterling, a horizontal well drilled to 9,200 ft in the field and completed in August 2010, tested for 21 b/d of oil.

Also in East Texas, Gastar planned to test the Eagle Ford Shale/Woodbine Formation, called the Eaglebine, at its 7H Wildman, but completed the well in the deeper False Buda. In June 2011, the company said it was examining cores from Belin #3, which it completed in the deeper Glen Rose, for production potential from the Eaglebine.

Farther east in Louisiana, the Indigo Minerals II LLC was formed from Indigo I assets and equity from Indigo I investors to explore the Eagle Ford in central Louisiana, where Indigo II held 240,000 leased acres.

In May 2011, Indigo II Louisiana Operating LLC permitted the Bentley Lumber 23H #1 horizontal well targeting the Eagle Ford Shale in Rapides Parish, La. It proposed the well

Today, numerous wells dot Hawkville Field, in the core of the Eagle Ford Shale play. (Photo by Lowell Georgia)



to a measured depth of 15,500 ft, including a 4,000-ft lateral. That well is some eight miles north of the company's vertical Bentley Lumber 32 #1 well, drilled to the Eagle Ford in Vernon Parish.

Indigo also said that Devon Energy Inc. had accumulated some 250,000 net acres in the area targeting the same interval, including the high-resistivity section at the base of the Eagle Ford, which also is called the Tuscaloosa Marine Shale.

Current drilling, permitting, and projected activities show plenty of room for growth in the Eagle Ford in South Texas with plenty of potential for expansion to the east.

## Key Players

### Abraxas Petroleum Corp.

- *Entered through Edwards Formation properties*
- *As of May 2011, held 9,586 acres in Eagle Ford*

Like many other companies in the Eagle Ford, Abraxas Petroleum Corp. entered the play through properties held by production in other zones.

In this case, Abraxas held production in the Edwards Formation. It leveraged that property into a joint venture with Rock Oil Co. in August 2010. In exchange for 8,333 net acres of land con-

tributed by Abraxas, Rock put up US \$25 million to form Blue Eagle Energy LLC for a 50-50 joint venture. Rock also committed to contribute another \$50 million to take over 75% of the Abraxas-operated venture.

In a May 2011 presentation, Abraxas said it held 9,586 acres in the Eagle Ford, gross to the Blue Eagle joint venture. That acreage contained 60 net unrisked drilling locations. It planned four wells in 2011 and would be carried on the \$34 million in capital costs for the drilling program.



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In its 2010 annual report, Abraxas said it drilled the T-Bird 1H in DeWitt County, Texas, to 19,450 ft, including a 5,700-ft lateral leg in the Eagle Ford. It put the well online in January 2011 at a restricted rate of 5.8 MMcf/d of gas, 340 b/d of condensate, and more than 500 b/d of natural gas liquids with a flowing tubing pressure of 8,500 psi on a  $\frac{1}{4}$ -in. choke. That well produced 69,000 boe in its first 45 days online.

Liquids content of production in the sweet spot of the Eagle Ford makes a big difference in revenues from a well. The example below assumes a price of \$4/Mcf for gas, \$100/bbl for condensate and \$50/bbl for natural gas liquids. (Graph courtesy of Aurora Oil & Gas Ltd.)

The Blue Eagle venture then agreed to participate with a 43.9% working interest in the Matejek Gas Unit 1-1, drilled by Talisman Energy to a measured depth of approximately 17,865 ft, including a 3,600-ft lateral leg, according to the Abraxas first-quarter 2011 report. The company planned to complete the well with a multi-stage frac treatment.

### Anadarko Petroleum Corp.

- One of the most active operators in the play
- Made deals with KNOC and TXCO Resource

Anadarko Petroleum Corp. locked in a substantial position in the Maverick Basin and has grown into one of the most active operators in the Eagle Ford play.

The company held some 400,000 acres in the play before it signed a US \$1.55 billion deal with South Korea's Korea National Oil Corp. (KNOC). That gave KNOC a 33.3% share in Anadarko's properties in the basin. KNOC's contribution will come entirely as drilling carries totaling 100% in 2011 and 90% thereafter until the contribution is used, probably by the end of 2013. KNOC will receive approximately 80,000 net acres in the Eagle Ford and another 16,000 acres in the deeper Pearsall gas shale.

This was the second important deal in the shale for Anadarko. Early in 2010, Anadarko paid \$93 million to buy 93,000 net acres of bankrupt TXCO Resource Inc. interests in the area. That gave Anadarko a 75% interest in the properties.

In the fourth quarter of 2010, before the venture was signed, Anadarko said it planned to double its 2010 drilling activity to more than 200 wells in 2011. It also said it became the largest producer in the play during the fourth quarter.

By February 2011, the company said it planned to accelerate its activity by adding another drilling rig to raise its count in the Eagle Ford to 10.

In a May 2011 presentation, Anadarko said it held 350 MMboe in net risked resources in the combined Eagle Ford and Pearsall shales. Its Eagle Ford wells were expected to produce more than 450 Mboe each over their lives. The company held more than 2,000 identified drill sites with an infrastructure backbone in place to process and move production.

In the company's current production on its 200,000 net acres, output measured 46% oil, 27% gas, and 27% natural gas liquids.

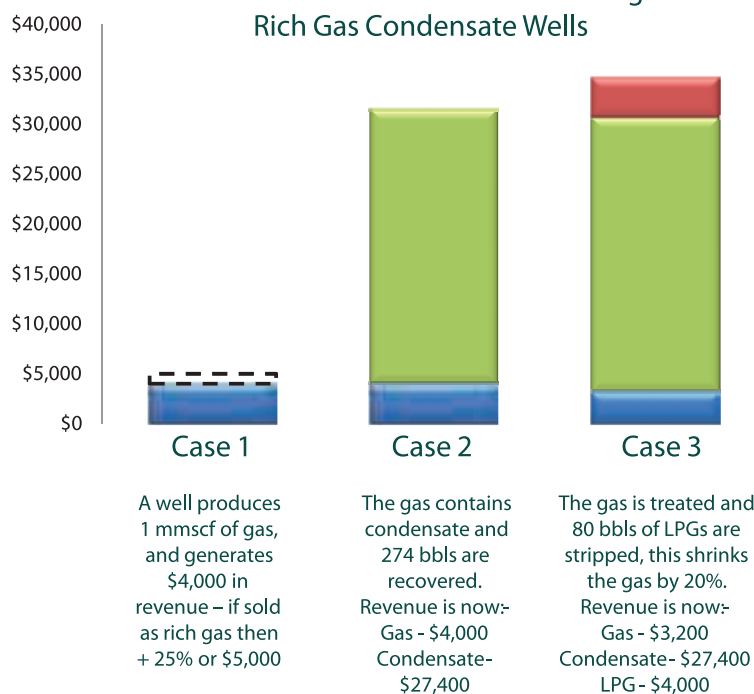
### Aurora Oil & Gas Ltd.

- Based in Perth, Australia
- Has key area in Sugarkane Field

Perth, Australia-based Aurora Oil & Gas Ltd. locked up a strong position in the sweet spot of the Eagle Ford play and has leveraged its activity in the area to a substantial drilling program.

Its key area is in Sugarkane Field, where it holds 74,800 gross, 15,760 net, acres with areas of mutual interest (AMI) in adjacent Sugarloaf, Longhorn, Ipanema, and Excelsior fields. It reached that figure late in 2010 with the acqui-

Incremental Value of Production from Sugarkane Rich Gas Condensate Wells



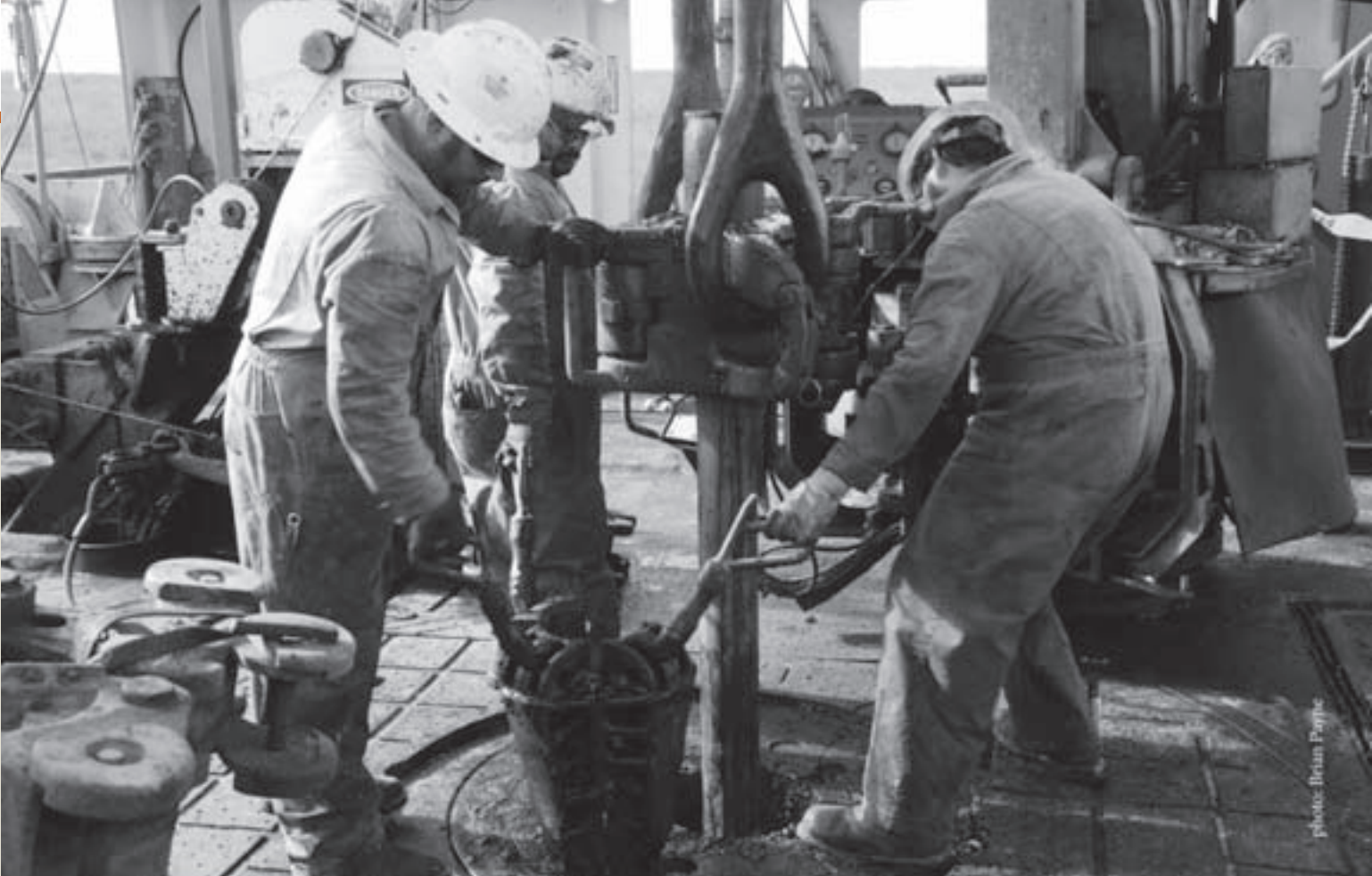


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sition of an additional 5,100 net acres in the AMI area. Hilcorp Energy operates wells in the AMIs through a farm-in agreement.

In a June 2011 presentation, the company said it had drilled 40 wells and put 30 on production by May 24, 2011. It had converted most of its possible reserves to probable by that time and planned to drill another 40 wells by the end of 2011, for a total of 60, with 70 total wells on production and 80 wells drilled by the end of the year. It planned to reach 140 wells by the end of 2012.

The company was running four rigs in early 2011 but added another rig to the play in June. Those rigs average 20 days from rig-up to rig-down at a well site.

An independent engineering company estimated Aurora proved, probable, and possible reserves at 82.9 MMboe with 53 MMboe of those reserves in oil and condensate.

Aurora produced a net 2,000 boe/d, after royalties, from the acreage in May 2011 and planned to raise that net figure to 5,000 boe/d by the end of 2011 with an average production of 3,400 boe/d for the full year.

The company's AMI areas are in Live Oak, Karnes, and DeWitt counties in Texas.

The company also said Hilcorp's US \$3.5 billion sale of Eagle Ford properties to Marathon Oil Corp. would accelerate development on the land.

### **Cabot Oil & Gas Corp.**

- *Eagle Ford is key investment choice*
- *Plans 25 net wells in 2011*

Cabot Oil & Gas Corp., better known for its activities in the Marcellus Shale in the Appalachian Basin, picked out the Eagle Ford Shale in Texas as its sole investment choice in its southern region for 2011.

In a May presentation, the company said its Eagle Ford wells, with natural gas liquids, offer the company a 66% rate of return at an oil price of US \$90/bbl and a gas price of \$5/Mcf. That compares with a return of more than 100% for Marcellus gas at a \$5/Mcf gas price and a return of 90% on the company's Bakken/Three Forks wells in the Williston Basin.

Although it plans to invest only in the Eagle Ford in its south region, another operator will carry

the company for wells drilled in the Haynesville/Bossier play in 2011 and 2012.

At the time of the presentation, Cabot held more than 60,000 acres in four fields in the liquids-rich portion of the Eagle Ford: in Powderhorn Field in Zavala County; Harlow Field in Frio and Atascosa counties; Presidio Field in Atascosa County; and Buckhorn Field in Frio, Atascosa and La Salle counties.

Its best Buckhorn Field well, the Arminius Energy Trust 1H, tested for an initial potential of 1,042 boe/d and a 30-day average of 814 boe/d from a 5,820-ft lateral.

Overall, Cabot has 400 to 500 potential locations with a 50% to 100% working interest, and it has a 100% success rate to date, thanks partially to 3-D seismic shot over 95% of the acreage. Its properties hold a resource potential between 150 MMboe and 300 MMboe.

The company plans 25 net wells in 2011 and has lined up a dedicated frac crew for the year.

### **Carrizo Oil & Gas Inc.**

- *Ranks Eagle Ford at top of 2011 investment list*
- *Sold Barnett properties to fund Eagle Ford drilling*


Like other companies working multiple unconventional plays across the US, Carrizo Oil & Gas Inc. ranked the Eagle Ford Shale at the top of its list, according to the amount of money planned for investment by the company in 2011.

According to an April 2011 presentation, the company invested US \$30 million in the Eagle Ford in 2010 and raised that number to \$130 million in 2011, the highest of any area of any play on Carrizo's \$281 million drilling budget for the year. That doesn't count a drilling carry by partner Reliance Industries of India on Carrizo's 118,000 acres of Marcellus Shale properties.

It held 33,000 net acres of properties in the Eagle Ford, most in the condensate window shallower than 10,000 ft, primarily in Dimmit, McMullen, and La Salle counties in June 2011. It estimated 80% of that acreage would be drillable, with room for more than 114 wells on 160-acre spacing. It has three rigs working the properties.

If the company's calculations prove accurate, it can produce 400 Mboe per well and achieve total reserves of 45.6 MMboe on its current holdings,





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**20**

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drilled last 18 months

although the company continues to evaluate and acquire leases.

It drills wells with 5,000-ft laterals and 18 frac stages. That technique yielded initial potentials of more than 1,000 boe/d on its first three wells. Its fourth and fifth wells, both on restricted flow, tested for 735 boe/d and 815 boe/d, respectively. Production consisted of 70% liquids and 30% natural gas.

In the April presentation, the company combined Eagle Ford and Niobrara Shale results. With three Eagle Ford wells and one Niobrara well completed, the company finished 2010 with production of 1,800 boe/d from the formations. Plans call for year-end production of 5,000 boe/d from the two formations.

Drill pipe delivered to a rack near a drilling rig stands ready to make an Eagle Ford hole. (Photo courtesy of Chesapeake Energy Corp.)



Outlining economics, Carrizo said a well in the condensate window cost approximately \$6.5 million and returned 400 Mboe gross, 300 Mboe net, in reserves at a finding and development cost of \$21.67/boe. That gave it an internal rate of return of 84% with NYMEX prices of \$90 for oil and \$4 for gas. Undiscounted payout at a \$75 NYMEX oil price is 1.8 years.

With those numbers, it's no surprise the company agreed in May 2011 to sell nearly all its 13,000-acre top-tier Barnett Shale properties for \$104 million to KKR Natural Resources to assemble additional funds to drill the Eagle Ford and Niobrara formations.

### Chesapeake Energy Corp.

- No. 2 player in the Eagle Ford
- JV deal with China's CNOOC

In slightly more than a year, Chesapeake Energy Corp. bounded from being a relative newcomer in the Eagle Ford Shale to the number two player in the popular South Texas formation as it aggressively pursued its decision to focus on liquids-rich plays.

The company's fourth quarter 2009 report said it held 80,000 net acres of Eagle Ford land with no proven reserves and 50 risked, net undrilled well locations on 160-acre spacing and average estimated resources of 4.3 Bcfe of gas per well, or risked unproved resources of 200 Bcfe, and unrisked unproved resources of 1.6 Tcfe of gas.

By the end of the first quarter of 2011, according to a June 2011 investor presentation, the company held roughly 680,000 gross acres (450,000 net acres after its CNOOC joint-venture agreement) in the Eagle Ford and 350,000 net acres in the deeper Pearsall Shale. Its Eagle Ford properties held 2,810 net risked undrilled well locations on 80-acre spacing with proved reserves of 203 Bcfe, 9 Tcfe in risked unproved resources, and 3 Bboe in unrisked, unproved resources.

Chesapeake's joint-venture deal, which gave China's CNOOC a one-third working interest on Chesapeake's Eagle Ford Shale acreage for \$2.2 billion in cash and drilling carries, earned the *Oil and Gas Investor* Excellence Award for the 2010 M&A Deal of the Year.

Among the company's better wells, the Gates 010-CHK-B 1286 5H tested for 1,519 b/d of oil and 4.5 MMcf/d of gas.

Chesapeake holds properties mainly in Webb, Dimmit, La Salle, Frio, McMullen, and Zavala counties, primarily in the oil and wet gas window of the Eagle Ford, according to IHS Inc.

### **Comstock Resources Inc.**

- *Has properties in five counties*
- *Drilled two net wells in first quarter of 2011*

Comstock Resources Inc. started working the Eagle Ford play in 2010 with the purchase of properties and began drilling quickly.

It completed two Eagle Ford wells in 2010, enough to provide 2% of the company's 201 MMcfe/d of 2010 production, according to a May presentation, and it planned to make the Eagle Ford a 10% production contributor in 2011 with the addition of 21 net wells at a cost of US \$168.9 million.

The 2010 purchase gave the company 20,859 gross, 18,320 net, acres of land. The three wells the company had completed by May added 1.4 MMbo of oil and 1.5 Bcf of gas to its proved reserves.

With its brief experience in the play, Comstock estimated a resource potential of 67 MMboe on its properties in Wilson, Karnes, Atascosa, McMullen, and La Salle counties. That number assumed 80-acre spacing with an estimated ultimate recovery of 400 Mboe/d well.

It drilled two more net wells in the first quarter of 2011.

### **ConocoPhillips Co.**

- *Entered the Eagle Ford play in 2005*
- *By mid-2011, had a core 220,000 net acres*

ConocoPhillips Co. entered the Eagle Ford play in 2005 through its acquisition of Burlington Resources, although it probably didn't realize the future value of the formation at the time.

By mid-2011, the company had a core 220,000 net acres in the shale play.

By February 2011, it said it would focus on the Eagle Ford, Bakken, and Barnett in the US Lower 48 states, along with liquids-rich shales in the Permian Basin.

The company's latest fact book says it is installing fiberoptic devices in its Eagle Ford and North Barnett wells, at first to measure temperature and acoustic properties, but it may add additional measurements later. It particularly mentioned continuing delineation activities in the Eagle Ford, and it still lists the Eagle Ford as a start-up operation.

During 2010, ConocoPhillips said it had drilled more than 45 wells in the Eagle Ford without a dry hole, and its net production averaged 3,000 b/d of liquids and 10 MMcf/d of natural gas. It had 11 rigs working the play by the end of 2010 and said it would add rigs to reach its goal of 150 new wells for 2011.

In a June 2011 investors report, the company said it planned a US \$2.9 billion drilling program in 2011 for the US and Canada, and it directed nearly half of that budget, \$1.4 billion, to the Eagle Ford. The Eagle Ford, Barnett and Bakken shales accounted for 63% of that program.

At that time, it had raised its rig count to 13 aided by three dedicated completion crews.

Its delineation program appears to be working well. In the June report, it said it completed its Esse 1 well for 1,012 b/d of liquids and 157 boe/d of wet gas. It completed the Schulte Prospect #1 for 1,210 b/d of liquids and 311 boe/d of wet gas, and it completed the Kennedy #1 for 1,254 b/d of liquids and 393 boe/d of wet gas. Its average for five recent wells was 1,050 b/d of liquids and 235 boe/d of wet gas.

### **El Paso Corp.**

- *Calls the Eagle Ford its flagship program*
- *Northern La Salle and western Dimmit counties*

El Paso Corp. continued its drive to lower risk and higher value during 2011, and its Eagle Ford central properties play a substantial role in that drive. It called the Eagle Ford its flagship program.

Near the end of 2009, El Paso executives were converting the company from a developer of onshore and offshore conventional plays to an operator of onshore unconventional plays with an emphasis on highly repeatable, factory-type production operations while building its cash-cow pipeline business.

In May 2011, the company said it would split into two parts: a pipeline and midstream company and an



**El Paso Eagle Ford Central Well Economics**

Total depth	7,000 to 10,000 ft
Lateral length	4,500 to 5,500 ft
24-hour initial potential	600 to 1,100 boe/d
Estimate ultimate recovery	400 to 900 Mboe
Internal rate of return before royalty	25% to 50%
Finding and development cost	\$12 to \$20/boe

*(Chart courtesy of El Paso)*

exploration company with major holdings in Altamont tight-sand gas, Haynesville Shale gas, tight Wolfcamp oil, and Eagle Ford Shale oil and gas.

In a May presentation, the company said it originally set aside a US \$1.3 billion exploration and production budget but later raised that figure to \$1.6 billion with the additional capital aimed at its Eagle Ford central properties in La Salle and Dimmit counties in South Texas.

The reasoning is sound. From the end of 2007 to the end of 2010, its unconventional net unrisked resource grew from 500 Bcfe of gas to 4.3 Tcfe driven by the Haynesville, Wolfcamp, and Eagle Ford with major contributions from the Wolfcamp and Eagle Ford.

It held 1,145 undrilled, unrisked Eagle Ford locations at the end of 2010 with properties in Atascosa and Frio counties in the northern oily part of the play and Webb County in the southern gassy part of the play. Its major emphasis is in its central area in northern La Salle and western Dimmit counties.

By May 2011, it had drilled 34 wells, completed 24 wells, and put 12 wells online in the central area and was running four rigs. Among those wells, the average length of a lateral was 4,550 ft with a 16-stage frac completion and initial potential production of 958 Mcf/d of gas and 633 b/d of oil.

Its production capacity from the central area in May 2011 was 5.6 Mb/d of oil and 12 MMcfe/d of gas, or nearly 8 Mboe/d, with about half of that capacity shut in awaiting infrastructure improvements. By the end of 2011, it planned to raise that capacity to about 16,000 boe/d with no infrastructure restrictions.

In the central area alone the company had 570 locations with more than 200 MMboe of potential

production on 120-acre spacing. If it reduced spacing to 80 acres, the company estimated it would add 100 MMboe and 80 drilling locations, assuming a gas price of \$4/MMBtu, an oil price of \$80/bbl, and a natural gas liquids price of \$56/bbl.

The company has improved efficiency, cutting its drilling time to 12 days in the first quarter of 2011 from 24 days in the second quarter of 2010.

It plans to raise its rig count in the central area to between five and seven by 2013.

**EOG Resources Inc.**

- *Net 23 Mboe/d as of March 31, 2011*
- *Has a 100% success rate in the play*

Early in 2010, EOG Resources Inc. didn't list the Eagle Ford Shale among its top plays, like the Bakken Shale and Barnett Combo. Now, it says it has captured the largest net position in the biggest Lower 48 crude oil play in the past 40 years.

In a June 2011 presentation, EOG said it was the biggest producer in the Eagle Ford with a net 23 Mboe/d on March 31, 2011.

In June, it held 520,000 net acres in the oil window, 26,000 net acres in the wet gas window, and 49,000 net acres in the dry gas window.

The company claimed a potential 690 MMbbl in oil reserves, 100 MMbbl of natural gas liquids (NGLs), and 661 Bcf in dry gas.

It has a good reason for the love affair with the Eagle Ford. It gave the company the opportunity to invest US \$10 billion to \$15 billion for after tax returns between 95% and 140% on wells that produce 40% of their reserves in the first five years.

Proving the repeatability of wells in the Eagle Ford, EOG has a 100% success rate in the play. It drilled 96 wells in 2010 and still says the play is in "the first inning of development." After that strong first inning, it plans a 250-well program in 2011 with 21 drilling rigs at work.

EOG also has brought online some of the play's stronger wells, including the 3H Sweet Unit in Eagleville Field in Gonzales County for 1,718 b/d of oil and 1.74 MMcf/d of gas, the 4H Spahn Farms Unit for 1,259 b/d of oil and 1.29 MMcf/d of gas, the 1H Cusack-Clampit for 1,812 b/d of oil and 1.8 MMcf/d, the 2H and 4H Hansen Kullin Unit wells for 1,625 and 1,700 b/d, respectively, and the 4H



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Peeler Ranch for more than 1,300 b/d of oil, according to EOG and IHS Inc.

A typical oil well returns 77% oil, 11% NGLs, and 12% gas.

It also expects infrastructure to improve in 2012. Now, the company must ship some liquids by rail.

EOG also completed its first successful horizontal gas well in the Eagle Ford in the fourth quarter of 2010, according to IHS Inc. The 100H Tully C. Garner in Webb County produced into the pipeline at a restricted rate of 2.8 MMcf/d of gas and produced 239 b/d of condensate.

### **Escondido Resources II LLC**

- *Has properties in three counties*
- *Has four Eagle Ford wells*

Escondido Resources II LLC works its Webb, La Salle and McMullen County properties to reach pay in the Olmos/Escondido and Eagle Ford Shale formations with horizontal wells.

The original Escondido Resources LLC drilled more than 150 wells to the Olmos/Escondido and later sold its assets to Swift Energy in 2007.

The management team stayed intact and Escondido Resources II LLC proceeded with the same objectives in the same area of South Texas. By early 2010, the team had acquired acreage prospective for Eagle Ford, participated in seven Eagle Ford wells in La Salle County, and drilled its first Eagle Ford well with a two-stage frac treatment in a 5,600-ft lateral.

In March 2011, the company said it sold 11,050 net acres of its Eagle Ford properties for \$115.3 million to a company that was not identified. Escondido retained some 60,000 net acres in the Escondido/Olmos play in northern Webb County and kept rights to the Eagle Ford in 40,000 of those acres.

Its first Webb County-operated Eagle Ford well produced more than 1 Bcf of gas in its first eight months online.

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By August 2011, Escondido had drilled four Eagle Ford wells, according to Bill Deupree, president. Its Matrix 11H was producing, its Stokes 1H was shut in awaiting pipeline connection, and it sold its Seidel-Gonzalez 1H and Seidel 2H in La Salle County — still awaiting completion—to Chesapeake Energy in December 2010. It had a 100% interest in all four wells.

By that time, the company also had participated in 13 additional Eagle Ford wells, all operated by Petrohawk. Nine of those wells were on the Martin lease in which Escondido held a 10% working interest, and the remaining four on the Storey lease, in which Escondido held a 15% working interest.

### **Exxon Mobil Corp.**

- *Predicts doubling of US unconventional production*
- *Holds 120,000 acres in the play*

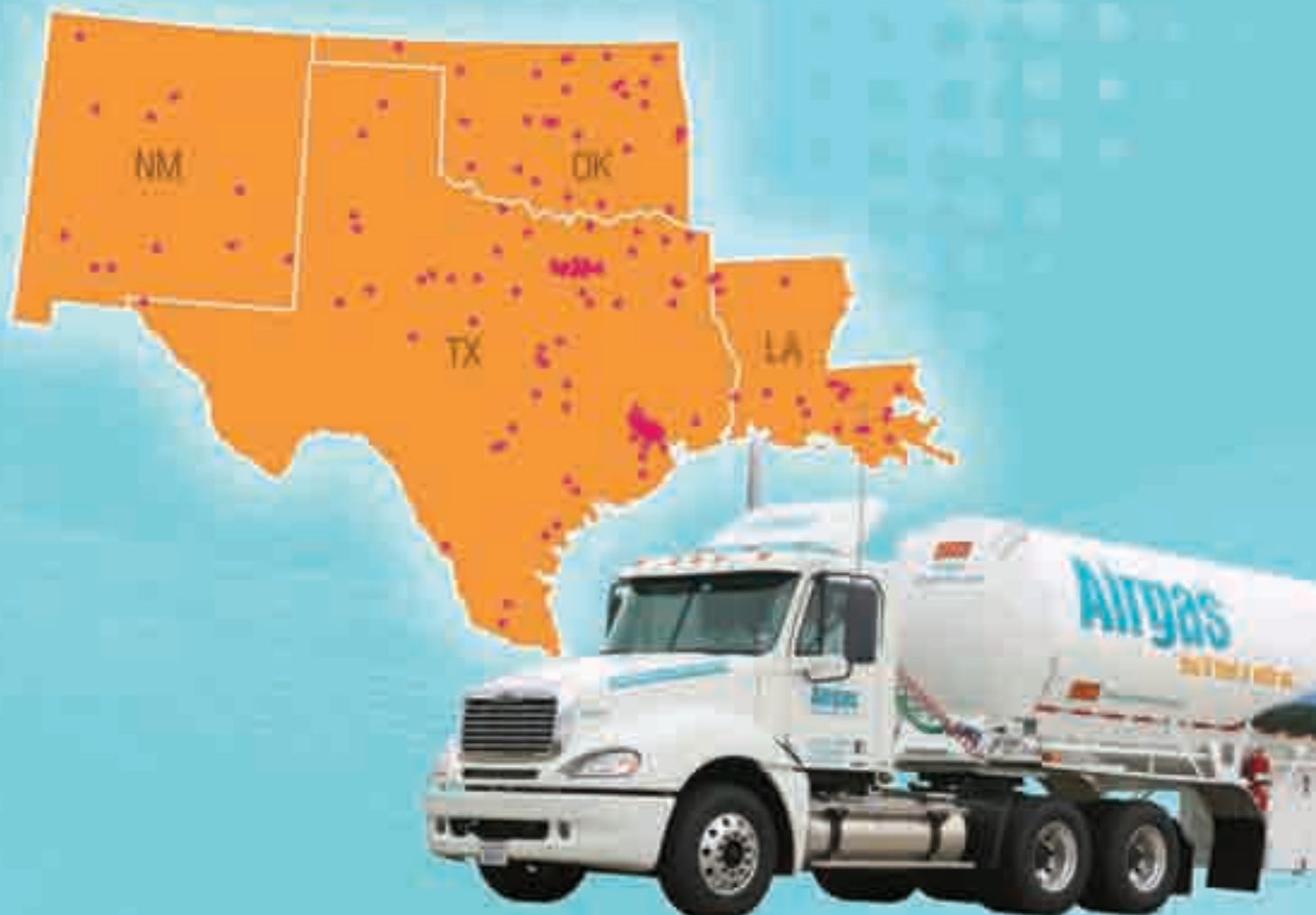
Exxon Mobil Corp. holds some 100 Tcfe of gas in unconventional oil and gas resources around the world with more than 50,000 drill sites in the US alone.

The reason? The company said it believes unconventional hydrocarbons have the potential to unlock significant future value and strong volume growth. It predicted US unconventional production would double from 500 Mboe/d in 2010 to 1 MMboe by 2020. With that in mind, the company has assembled unconventional resources amounting to more than 40% of its total 35 Bboe resource base.

In the US, those plays range from the Bakken Shale in the North and the Marcellus Shale in the Northeast; the Woodford, Fayetteville, and Barnett in the Midcontinent, and to the Haynesville/Bossier and Eagle Ford in the South.

The company holds 120,000 acres in the Eagle Ford play, picked up in its June 2010 acquisition of XTO Energy, and it drilled 15 wells in the trend in 2010.

One of those wells, according to IHS Inc., was the 6H Las Raices Ranch in Hawkville Field in north-eastern Webb County, drilled under the XTO name



and reported in November 2010. It drilled to a total depth of 15,018 ft with a true vertical depth of 9,770 ft, with the bottomhole location to the northwest. The well tested for nearly 5.7 MMcf/d of gas and 201 b/d of condensate.

The 3H Las Raices Ranch, completed in May 2010 by XTO about a half-mile to the southwest, tested for 5.22 MMcf/d of gas and 255 b/d of condensate as part of the same field. During August, that well produced 91 MMcf of gas and 4,062 bbl of condensate.

### Forest Oil Corp.

- *Holds 118,000 gross, 109,000 net acres*
- *Regards Eagle Ford economics 2nd to Granite Wash*

Forest Oil Corp. started acquiring acreage in the Eagle Ford Shale in 2009 and continued to grow its position into a substantial leasehold in the oil and wetgas windows of the play.

By June 2011, it held 118,000 gross, 109,000 net acres, most of it in the oil window in Gonzales and Wilson counties with a minor portion in the wetgas window in DeWitt County in South Texas. Those numbers were up from 106,000 gross (102,000 net) acres at the end of March 2010 with 81,000 net acres in the oil window.

In the second quarter of 2011, the Denver company divested 12,000 gross (10,000 net) acres with Eagle Ford potential in Wilson County for US \$110 million, but acquisitions added 4,000 net acres to leave Forest with 113,000 net acres at the end of the quarter.

In the first quarter of 2010, it planned to shoot seismic over parts of its acreage in the second and third quarters and to begin its drilling program shortly afterward.

In a first-quarter 2011 report, it said its first four wells produced at an average rate of 733 b/d of oil, or 787 boe/d. Its first operated well, in Wilson County, tested initially for 730 b/d of oil, but that number climbed to 915 b/d after the company installed a pumping unit.

It drilled four more wells into the Eagle Ford in the second quarter. Those wells tested at an average initial 24-hour production rate of 747 boe/d each.

With successes in the early part of the year, the company planned to add a third rig to its fleet in July 2011.

According to the June presentation, Forest held three proved undeveloped well locations at the end of March 2011 but had another 1,015 undeveloped locations targeting liquids and an unrisksed potential of 154 MMboe on its properties. It must drill 140 wells to hold its Gonzales and Wilson County acreage by production.

Offering reasons why it liked the play, the company said the formation had a high organic content, high porosity, and conductivity in a very brittle shale. It offered exceptional rates of return with payout often within a year.

It placed the Eagle Ford second only to the Granite Wash in attractive economics.

### GeoResources Inc.

- *Increasing leasehold position and drilling capability*
- *Has expanded its leases to 23,000 net acres*

GeoResources Inc. took a foothold in the Eagle Ford play and is increasing its leasehold position and drilling capability in the play.

By October 2010, the company assembled 22,000 net acres in the play and signed an agreement with Ramshorn Investments Inc., a Nabors Industries Ltd. affiliate, in which Ramshorn took a half interest, or 11,000 acres, in an area of mutual interest covering some 140,000 acres in southwestern Fayette County. GeoResources remained the operator with the other 50% working interest.

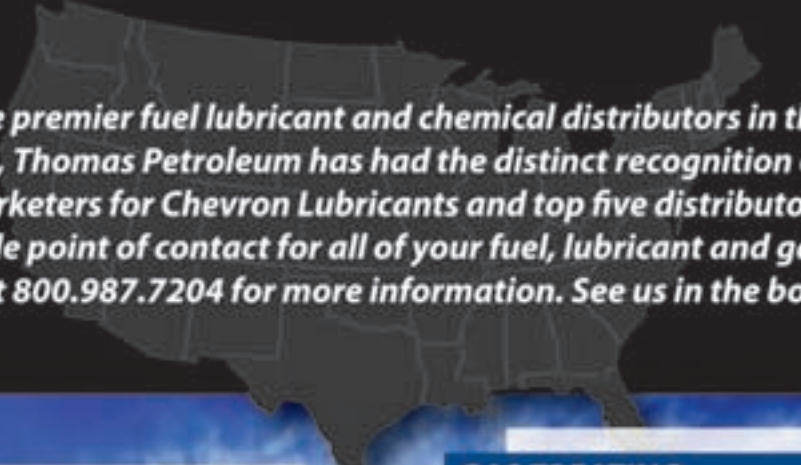
Ramshorn agreed to fund six horizontal obligation wells, and both companies agreed to acquire more acreage.

In January 2011, GeoResources set aside US \$15.8 million for the six carried-interest wells and seven additional wells in its Eagle Ford operations. By that time it had increased its Eagle Ford holdings to 21,000 net acres. Most of its leases had two- to four-year remaining terms, and the company planned to accelerate drilling and development in the play and to assemble additional acreage.

GeoResources still hadn't completed its first well by that time, but it planned 13 Eagle Ford wells during 2011 in the area where Ramshorn would provide a carried interest with no cost to GeoResources.

It had one rig working in January 2011, planned to add a second rig in the Eagle Ford during the summer, and a third by the end of the year.





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In a June 2011 presentation, the company said it had expanded its Eagle Ford leases to 23,000 net acres and had commitments for additional leasing.

It held 19,600 net acres in Fayette County, 3,300 net acres in Gonzales County, and a combined 2,100 net acres in Atascosa and McMullen counties.

It drilled its first well in February 2011, its second in April, and was drilling a third well in June. Geo-Resources planned to fracture its first two wells, both in Fayette County, in June using micro-seismic measurements to check fracture efficiency and to determine optimal well spacing.

### **GeoSouthern Energy Corp.**

- *Has high returns from DeWitt County position*
- *Signed arrangement with Petrohawk Energy*

GeoSouthern Energy Corp. is generating high returns from an Eagle Ford land position in DeWitt County.

The company signed an arrangement with Petrohawk Energy with Petrohawk drilling and completing wells on the property with a 66% interest in 53,000 net acres. Petrohawk estimated completed well costs at US \$6.5 million. After completion, GeoSouthern takes over operation of the wells.

In August 2010, GeoSouthern received \$28.5 million in financing from CLG Energy Finance for its DeWitt County development with Petrohawk with the understanding that the funding could be raised to as much as \$125 million.

Although GeoSouthern, as a private company, doesn't publicly report operations, its partner does.

Petrohawk calls the area its Black Hawk project and, in June 2011, said it held 69,000 net acres under lease in Karnes and DeWitt counties. It said its average working interest was 66% with a net revenue interest of 50% in the 27 wells drilled by that time.

Petrohawk said it drilled wells to true vertical depths as deep as 13,500 ft with an average 5,500-ft lateral and completed them with an average 18-stage frac. The properties held 27 proved developed wells and 41 proved undeveloped locations.

Petrohawk drilled 29 wells on the property with no dry holes in 2010 and budgeted 85 wells for 2011. It was running five rigs in the area in February 2011 with plans to go to seven rigs at the end of the first quarter and to 11 rigs by the third quarter.

It also said, "The Black Hawk area of the Eagle Ford Shale has become the company's dominant focus for high-return drilling in the current commodity price environment."

GeoSouthern also permitted an exploratory Eagle Ford Shale test, the 1 Frisbie Unit, in Gonzales County, IHS Inc. said in May 2011.

### **Goodrich Petroleum Corp.**

- *An aggressive independent in the play*
- *Spending 62% of 2011 drilling budget in the play*

Goodrich Petroleum Corp., one of the large number of aggressive independents in the Eagle Ford play, is using the play to grow into a larger company.

In a May 2011 presentation, the company said 1% of its proved reserves and 7% of its proved, probable and possible reserves were tied to the Eagle Ford, but it planned to spend US \$145 million, or 62% of its 2011 drilling budget, in the play.

In its first quarter 2011 report to shareholders, it reported completed wells on its 55,000 gross (40,000) net, acres of properties in La Salle and Frio counties.

It completed the Burns Ranch 7H in La Salle County with a 5,800-ft lateral and 21 frac stages for in initial potential of 940 boe/d made up of 822 bbl of oil and 700 Mcf of gas.

It completed the Burns Ranch 9H for 860 boe/d and the Burns Ranch 5H for 600 boe/d.

The Pedro Morales 7H in Frio County tested for 460 boe/d on pump.

In May 2011, Goodrich was completing its Burns Ranch 15H and 16H wells and started pad drilling with the Burns Ranch 19H, 20H, and 3H wells on its first pad. It was using a second rig to drill the Burns Ranch 17H.

That report said Goodrich had two rigs working full time and planned 22 to 26 wells in the Eagle Ford during 2011.

Its eight completed Eagle Ford wells averaged 675 boe/d.

### **Hilcorp Energy Co.**

- *Third-largest privately owned US independent*
- *Deals with Aurora Oil & Gas and Lucas Energy*

Hilcorp Energy Co., the third-largest privately owned independent in the US, farmed into a strong position in the Eagle Ford Shale play in deals with Aurora Oil

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& Gas Ltd. of Perth, Australia, and Lucas Energy Inc. of Houston that has worked well for the companies.

Those farm-ins represented only a small part of Hilcorp's activities in the play. In early June 2011, Marathon Oil Corp. said the company agreed to sell its major Eagle Ford holdings to Marathon for US \$3.5 billion in a deal that included 141,000 net acres in the black oil, volatile oil, condensate, and dry gas windows of the play. Marathon anticipated closing the deal in November 2011 with an effective date of May 1, 2011. Those properties include some 1,230 potential well locations in the liquids portion of the play.

Aurora held more than 18,000 net acres in the Sugarkane area with areas of mutual interest in the Sugarloaf, Longhorn, and Ipanema segments of the field, segments with contingent resources totaling 391 Bcf of gas and 72 MMbbl of liquids, according to a Netherland Sewell and Associates survey.

Aurora farmed out those interests to Hilcorp for a carried interest in a deal that allowed Hilcorp to earn up to half of Aurora's interests in Sugarloaf and Longhorn and five-eighths in Ipanema. Hilcorp opted to become operator in February 2010.

A Credit Suisse report on Aurora in May 2011 said the company had completed 15 wells in the play by the end of 2010 and planned another 60 wells during 2011 to reach 140 wells by the end of 2012. The companies added their fifth drilling rig in June 2011.

Aurora said it produced a gross 13,000 boe/d from the acreage by the end of April 2011 and would raise that figure to 5,000 boe/d by the end of 2011. Those properties are in Live Oak, Karnes, and DeWitt counties.

In early 2010, Hilcorp signed a joint venture agreement that allowed it to acquire an 85% working interest in Lucas properties in Gonzales County, below the base of the Austin Chalk or the top of the Eagle Ford, for cash and a 15% carry for Lucas to the tanks on the first two Eagle Ford wells drilled in 2010.

In March 2011, according to IHS Inc., Lucas said Hilcorp tested the 2H E.F. Hagen in Gonzales County and said it expected the well to meet or exceed expectations of 500 b/d. An offset well, the 1H E.F. Hagen tested for up to 350 b/d during flow back, and that was the second of its Gonzales County Eagle Ford producers.

## Laredo Energy LLC

- *Has been in and out of the play*
- *Has drilled 17 horizontal wells*

Unlike most companies in the Eagle Ford Shale play, Laredo Energy LLC has put together a good business model by selling out of the play and jumping back in again.

It sold its Laredo Energy I and II packages to Chesapeake Energy Corp. and its Laredo Energy III package to El Paso Corp. for combined revenues of some US \$800 million and bought back into the play after each sale.

Following the sale to El Paso in 2007, it found a lot of large companies driving prices higher in its Zapata County stomping grounds, so it moved one county north to look for better prices in Webb County, according to an *Oil and Gas Investor* report by Richard Mason from the Hart Energy Developing Unconventional Gas conference in April 2011.

After the sale, it started building its Laredo Energy IV package. Now, the company has drilled 17 horizontal wells to de-risk and delineate its Eagle Ford holdings. It also has wells in the Escondido, Wilcox, Austin Chalk, and San Miguel formations.

An electron microscope sample of the Austin Chalk showed the company that play looked a lot like the Eagle Ford in that area. Instead of a 300-ft-thick Eagle Ford section, it had the Eagle Ford with a 400-ft- to 500-ft-thick Austin Chalk lookalike sitting on top of it.

In April 2011, Laredo had 170,000 acres of leases in Webb County, with 134,000 of those acres prospective for Eagle Ford. Combined Austin Chalk and Eagle Ford potential offered 18 Bcfe of recoverable resource per 80 acres.

Glenn Hart, president and chief executive officer, said his company spent more on its Laredo Energy IV package than on the first three asset groups combined, and that it held more acreage and more reserves, including a possible 3,000 locations in the Eagle Ford alone.

He said he was considering another sale.

## Lewis Energy Group LP

- *Properties in three counties*
- *Drilled the first horizontal well in the play*

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large partner, Lewis Energy Group LP bills itself as the leader of the pack in the Eagle Ford Shale play in South Texas.

According to the company website, "Now, we are the most dominant drilling company on the Eagle Ford play — including most rigs, most acreage and most drilling." Much of its property is in La Salle, Dimmit, and Webb counties.

The privately owned company drilled the first well to the Eagle Ford in 2002 and drilled the first horizontal well to the now-popular shale. It also says it "is the most aggressive exploration and production company in this exciting play."

Although it hasn't released figures on its property position, Lewis Energy develops on its own properties, and it signed a US \$200 million deal in early 2010 to take in BP as a 50% partner on 80,000 acres of its land.

The company owns its own drilling rigs and runs its own completion equipment and crews.

Among recent wells, it completed the 2H Fasken-

State 1430 Gas Unit development well in Hawkville Field in Webb County in December 2010.

It drilled the horizontal well to 13,558 ft in the Eagle Ford at a true vertical depth of 9,460 ft. After fracturing, it tested the well for 6.68 b/d of condensate and 3.3 MMcf/d of gas through a  $\frac{1}{4}$ -in. choke with 3,431 psi of shut-in tubing pressure from perforations between 9,230 and 13,403 ft.

### Magnum Hunter Resources Corp.

- Holds 51,664 gross acres in the play
- Spending \$65 million in the play in 2011

Magnum Hunter Resources Corp. management re-focused the company in June 2009 as it acquired, drilled, and operated properties in three of the most prolific plays in the US to optimize profit opportunities.

Those plays were the Marcellus/Huron/Weir formations in Appalachia, the Bakken/Three Forks Sanish/Madison in the Williston Basin in North

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The reason for its Eagle Ford choice is simple. The company quotes a Credit Suisse Equity Research Report that said the Eagle Ford, at 59%, offered the second-highest rate of return among unconventional plays, beaten only by the Granite Wash at 60%.

The company has nine gross wells, seven operated, and was producing 1,198 boe/d from the Eagle Ford in June 2011, according to a corporate presentation.



The Eagle Ford Shale play offers some of the highest returns of any unconventional play active in the United States. *(Chart courtesy of Magnum Hunter Resources Inc.)*

with plans to drill 20 gross (10.9 net) wells for the year in Gonzales, Atascosa, and Lavaca counties.

## Marathon Oil Corp.

- Entered the play through acquisitions
- Doubled holdings with Hilcorp acquisition

Marathon Oil Corp. entered the Eagle Ford play through a series of acquisitions as it followed a

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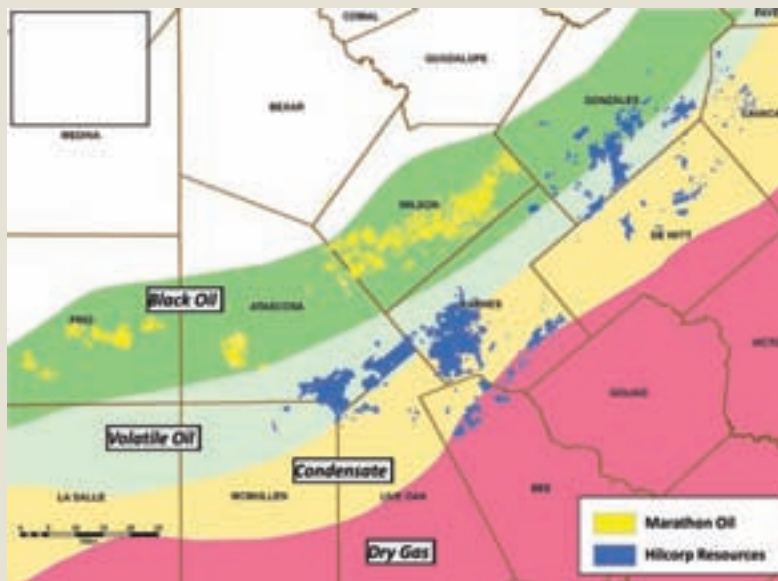
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Marathon properties and properties planned in Hilcorp acquisition clearly show the black oil, volatile oil, condensate and dry gas areas of the Eagle Ford formation in South Texas. (Map courtesy of Marathon Oil Corp.)



change in corporate strategy from pursuing a few large plays to working large, scalable, liquids-prone unconventional plays, a strategy that will make it a top-five participant in the Eagle Ford.

Marathon started acquiring properties in the Eagle Ford in 2006 but accelerated that activity more recently. The company entered into a 50-50 joint venture with Lucas Energy that would let Marathon operate wells below the Austin Chalk, primarily Eagle Ford and Buda wells, on some 1,000 net acres of Lucas land, according to IHS Inc.

In November 2010, Marathon entered into an agreement with Denali Oil & Gas Management LLC under which Marathon paid Denali \$10 million and agreed to drill and complete four wells to earn 17,000 net acres in the Eagle Ford. Marathon also picked up an option to buy Denali's remaining 58,000 net acres in the shale in Wilson and Atascosa counties at a total cost, for all properties, of approximately US \$209 million for the full 75,000 acres.

In June 2011, Marathon said it reached a definitive agreement to buy the assets for Hilcorp Resources Holdings LP. That acquisition, scheduled to close Nov. 1, 2011, would more than double Marathon's holdings to 285,000 net acres. If closed, the acquisition would have an effective date of May 1, 2011.

Hilcorp has six rigs at work on its Eagle Ford properties, and Marathon has two more on its properties. Marathon has ordered another five rigs and

plans to have 20 rigs at work within 12 months of closing the deal. Marathon also expected the arrangement to help raise its Eagle Ford production to a net 100,000 boe/d by 2016.

In a June presentation on the Hilcorp acquisition, Marathon said it would pay \$3.5 billion, subject to adjustments at closing, to acquire 217,000 gross (141,000 net) acres with a potential addition of another 14,000 acres.

At that time, production from the properties had reached 7,000 boe/d, and Marathon

expected the properties to produce 12,000 boe/d, 80% liquids, by the end of 2011.

With the acquisition, Marathon's 285,000 net acres would be 90% operated with an 80% working interest at an average cost of \$15,000 per acre. It would contain a resource potential of some 600 MMboe.

The Hilcorp properties contain 1,850 potential drilling locations at a combined \$5.5 million to \$8.1 million in well costs, including facilities. Its 30-day initial potentials ranged from 350 to 1,500 boe/d and gross estimated ultimate recoveries from 300 to 840 Mboe per well.

The Eagle Ford also would become Marathon's second-largest unconventional play behind the Bakken, where it holds 375,000 net acres.

The company's existing properties are in the black oil window in Wilson, Atascosa, and Frio counties. The Hilcorp properties would add black oil and volatile oil in Gonzales County, volatile oil in Atascosa and McMullen counties, volatile oil and condensate in Lavaca County, condensate in Dewitt and Live Oak counties, and condensate and dry gas in Karnes and Bee counties.

### Modern Exploration Inc.

- Entered Eagle Ford in late 2009
  - Completed first horizontal Gonzales County well
- Modern Exploration Inc., with a history of success in the Barnett Shale play, transferred its experience into the Eagle Ford in late 2009.

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The company's first Eagle Ford well, the 1 Texas Two Step, also was the first horizontal Eagle Ford well in Gonzales County. It completed the well in January 2010 and tested it for 185 b/d of oil and 200 Mcf/d of gas through fractured perforations between 10,740 and 11,849 ft, according to IHS Inc.

The well was a re-drill of a 1993 Austin Chalk well that tested for 1,041 b/d of oil and 500 Mcf/d of gas.

Modern followed its success by drilling the 1H Mostyn, Brothers 3H, Brothers 1H, No. 1 Mission Valley, and No. 1H George, all drilled in 2010. The Mostyn well tested for 339 b/d of oil and 50 Mcf/d of gas.

The company's website does not list any Eagle Ford wells during 2011.

### Murphy Oil Corp.

- *Producing 4,000 b/d and 4 MMcf/d as of June*
- *Expects 60,000 boe/d by 2015*

Murphy Oil Corp. works promising plays around the world, but the Eagle Ford Shale in South Texas is turning into one of the company's more promising efforts.

According to a June 2011 presentation, Murphy was producing 4,000 b/d of oil and 4 MMcf/d of gas. It expects its production from the Eagle Ford to climb to 60,000 boe/d by 2015, or 20% of the corporate world total.

It had drilled 26 wells by June 2011, 17 producing and nine more awaiting completion. It planned 20 exploration and 25 development wells for the year. At that time, it was working four rigs in the play and planned to double that number during 2011 to work its 220,000 acres of properties in Dimmit, La Salle, Web, Atascosa, McMullen, Wilson, Karnes, and DeWitt counties.

Most of its wells to date have looked for oil in Eagleville Field in Karnes County. Two of its four rigs were working that field, and it had one rig each in its Tilden and Catarina fields. It also had a dedicated frac crew capable of completing three to five wells a month.

Among its recent wells, the A 1H Schendel "A" in Eagleville Field tested for 554 b/d of oil and 313 Mcf/d of gas from a total depth of 16,929 ft at a true vertical depth of 11,886 ft, according to IHS Inc.

The company completed its first Eagle Ford well in January 2010. That well, the George Miles 1H in

McMullen County, tested for an initial potential of 7.5 MMcf/d.

At that time, the company held only 100,000 acres in the play.

### Newfield Exploration Co.

- *Adding 30 to 35 wells to its Eagle Ford inventory*
- *Average drilling times: eight to 10 days*

The Eagle Ford Shale isn't Newfield Exploration Co.'s biggest onshore play, but it is a strong asset for the company, and Newfield will use some US \$250 million in corporate capital expenditures in 2011 to add 30 to 35 wells to the company's inventory in the play.

It holds 335,000 acres of land in the Maverick Basin and plans to examine the deeper Pearsall gas shale as well as the Eagle Ford, Newfield said in a May 2011 presentation.

Meanwhile, the company has honed its drilling experience in the Eagle Ford with average drilling times between eight and 10 days. It also drilled what it called a "best-in-class" well that took seven days to drill and case. To speed up operations, Newfield also contracted with a major service company late in 2010 to provide frac equipment and people in 2011 and 2012.

In a May 2011 release, Newfield said it was running two to three operated rigs on its 335,000-net-acre position in the basin. To date, the company has drilled about 20 wells in the play.



A Newfield rig in South Texas works the Eagle Ford Shale on approximately 335,000 acres controlled by the company. (Photo courtesy of Newfield Exploration Co.)



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The company said it was completing recent wells with 5,000-ft laterals at a cost of less than \$2 million gross to casing. Completion costs add another \$4.5 million to \$5 million to that figure.

The six wells it had on production for more than 30 days in January 2011 produced an average 630 boe/d of peak production and 30-day figures of approximately 400 boe/d.

It November 2010, it jumped into the play in a full-scale assault as it acquired more than 350,000 gross, 300,000 net, acres in the play from TXCO through a bankruptcy court negotiation. It got the properties for around \$217 million, or about \$723 an acre, including minimal (less than 1,000 boe/d) of production as a bonus. Some leases now sell for \$15,000 an acre.

#### **Penn Virginia Corp.**

- *Active program with major capital expenditure*
- *Best well tested for 1,876 boe/d*

Penn Virginia Corp. holds a relatively small but

concentrated position in the Eagle Ford play, relative to the biggest players, but it is working an active program with a major capital expenditure.

In a June 2011 release, the company said it had six producing Eagle Ford wells in which it had an approximate 83% working interest. Those wells were producing 4,096 b/d of oil and 2.07 MMcf/d of gas. The company expects 150 b/d of natural gas liquids per million cubic feet of natural gas.

The company completed its first well, the Gardner #1-H, in February 2011 for 1,250 boe/d. Its best well tested for 1,876 boe/d.

In addition to the six existing wells, Penn Virginia was drilling three more wells and had three additional wells awaiting completion. It also lined up fracturing services for the Eagle Ford and other plays in East Texas and Oklahoma.

It has three rigs at work with plans to drill 29 gross, 24.3 net, wells in 2011 at a capital cost of US \$187 million.



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In a June 2011 presentation, the company said it planned to build its acreage position in the Eagle Ford. It already has 90 to 115 gross undrilled locations on its 12,700 net acres in Gonzales County.

It expects a pre-tax rate of return of 39% on a 371 MMboe well with a cost of \$7 million and a gas price of \$5/MMBtu.

### Petrohawk Energy Corp.

- *One of earliest entrants and largest leaseholders*
- *Ramping up operations in 2011*

Petrohawk Energy Corp., one of the earliest entrants and largest leaseholders in the Eagle Ford play, worked its basic research in its three Eagle Ford properties during 2010 and ramped up operations in 2011.

That powerful position, along with strong positions in the Haynesville Shale and the Permian Basin, introduced potential for a new, strong operator in all three areas. In mid-July 2011, BHP Billiton of Australia said it planned to buy Petrohawk for US \$38.75 a share, or \$15.1 billion, including Petrohawk's \$3 billion in debt. Petrohawk directors unanimously recommended approval by shareholders.

The company had \$8.2 billion in gross assets at the end of the first quarter of 2011.

Both companies expect to complete the acquisition by the end of the third quarter of 2011.

Petrohawk discovered massive Hawkville Field in the Eagle Ford play in 2008 and already had 160,000 net acres in the play at that time.

According to a June 2011 presentation, the company held 236,000 net acres of leases in Hawkville Field in La Salle and McMullen counties alone, another 69,000 net acres in Black Hawk in Karnes and DeWitt counties, and 77,000 net acres in Red Hawk in Zavala County.

In Black Hawk, its main area of operations in the Eagle Ford, it had proved reserves of 42 Bcf of gas and 11 MMbbl of condensate. It also had 759 Bcf, 232

MMbbl of condensate, and 96 MMbbl of natural gas liquids (NGLs) in risked resource potential.

It was operating nine drilling rigs in Black Hawk and had drilled 35 wells by the end of March 2011 with average initial potentials of 2.8 MMcf/d of gas, 1,400 bc/d, and 275 bNGL/d. It estimated ultimate recoveries of 1.8 Bcf, 550 Mbc, and 220 MbNGL per well. It planned 85 wells for the full year.



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It also added the 10,500-acre Black Hawk extension in December 2010 south-southwest of Black Hawk. That property has no production yet, but Petrohawk plans the first well for 2012.

The company's core Hawkville Field holds 415 Bcf, 8MMbc, and 27 MMbNGL in proved reserves and 6.6 Tcf, 174 MMbc, and 399 MMbNGL in risked resource potential.

It will run five rigs in that field during 2011. It drilled 36 operated wells and five non-operated wells in the field in 2010 and budgeted 51 operated and 23 non-operated wells in 2011.

The company's Red Hawk Field still is listed as an exploration area. The company drilled three wells in that field and put two on production in 2010. It plans five wells for 2011.

Petrohawk held 3.4 Tcfe in proved reserves and 27.4 Tcf, 406 MMbc, and 495 MMbNGL in risked resource potential at the end of the first quarter of 2011. It planned 147 operated and 17 non-operated wells for the year, or 164 gross wells.

To help provide funds for the ramped-up 2011 operations, the company sold its half interest in KinderHawk Field Services and a 25% share in its gas gathering and treating operations in the Eagle Ford to Kinder Morgan for \$855 million and \$65 million in debt. Kinder Morgan also agreed to invest \$220 million for a new crude/condensate pipeline to transport an initial 50,000 bc/d for Petrohawk from the production area to the Houston ship channel. That line will have a capacity of 300,000 bc/d.

Petrohawk produced an average 67 MMcfe/d of gas during 2010, up from an average 20 MMcfe/d the previous year. It was producing 125 MMcfe/d at the end of 2010 and said it planned to produce 770 MMcfe/d by the middle of the first quarter of 2011 with an average 885 MMcfe/d for all of 2011.

A new HiWAY frac design will help the company reach those goals. The treatment resulted in a 32% increase in production and a 42% increase in pressure on the same choke size after 90 days of operations on test wells compared with the company's previous hybrid design.

### **PetroQuest Energy Inc.**

- *As of June 2011, had 1,600 net acres in the play*
- *"Aggressively looking" for additional acreage*

PetroQuest Energy Inc. stepped into the Eagle Ford play late in 2010 after honing its skills in operations in East Texas, the Fayetteville Shale, and the Woodford Shale. It wasted no time in going to work.

In a June presentation, PetroQuest said it had 3,200 gross, 1,600 net acres, in the Eagle Ford with 600 net acres in Dimmit County and 1,000 acres in La Salle County. By that time, the company was completing its first well in Dimmit County and was drilling its second well, this one in La Salle County. Both wells are in the volatile oil window of the Eagle Ford. It planned three wells for the full year and estimated a net 16 Bcfe of gas in reserves.

The La Salle County well is the 1 Hunter in Eagleville Field, which has an anticipated total depth of 8,500 ft including a mile-long lateral to the northwest.

The company wants to expand. It's "aggressively looking" for additional acreage and expects to expand its land holdings during 2011. It has directed 13% of its \$110- to \$120-million capital budget for 2011 to the Eagle Ford.

### **Pioneer Natural Resources Co.**

- *Regards Eagle Ford as a top-priority play*
- *Has about 310,000 gross acres*

Pioneer Natural Resources Co., the most active leaseholder and producer in the Spraberry play in West Texas, raised the Eagle Ford play to a top priority activity, as well.

According to the company website, it has roughly 310,000 gross acres prospective for the Eagle Ford. Its first well, drilled in 2009, tested for 11.3 MMcfe/d of gas and its second well for 17 MMcfe/d. Those results, and the company's knowledge of the area, prompted a sharp increase in activity.

In June 2010, the company signed a \$1.15 billion agreement with India's Reliance Industries Ltd. for work in the Eagle Ford. Under that agreement, Reliance paid \$226 million in cash and will provide \$879 million in future drilling carries for a 45% interest in 263,000 net acres of land prospective for the Eagle Ford, a net 118,000 acres.

That means Pioneer can invest \$1.1 billion of its \$1.6 billion in 2011 drilling capital expenditures in its Spraberry play and devote \$110 million to the Eagle



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Ford. That \$110 million represents 25% of drilling costs, and Reliance will carry the company for the remaining 75% of costs.

Newpek, a subsidiary of ALFA, S.A.B. de C.V., was already a joint venture partner in the Eagle Ford and, after the Reliance entry, retains a 9% interest.

The joint venture holds properties in McMullen, Atascosa, Live Oak, Bee, Karnes, and DeWitt counties and produces from all but McMullen and Bee counties.

Some 20% of Pioneer's acreage is in the dry gas arc of the Eagle Ford. Another 45% is in the lean condensate area with about 50% gas, 30% natural gas liquids (NGLs), and 20% condensate. The remaining 35% is in the rich condensate areas with 30% gas, 50% condensate, and 20% NGLs.

That makes a difference in profits. With a well cost between \$7 million and \$8 million and current strip prices in the New York Mercantile Exchange, the high-condensate area offers a 100% before-tax internal rate of return, while the low-condensate area offers a 70% return, excluding the benefits of the joint venture.

The company averaged 2 Mboe/d of net production in the Eagle Ford during 2010 with seven rigs running. That rate increased to 5 Mboe/d in first quarter of 2011 with 10 rigs and was projected to increase to 7 Mboe/d to 9 Mboe/d in the second quarter, 18 Mboe/d to 23 Mboe/d in the second half of the year with 12 rigs, 26 Mboe/d to 30 Mboe/d in 2012 with 14 rigs at work, and 40 Mboe/d to 45 Mboe/d in 2013 with 16 rigs working.

Pioneer also is running two company-owned frac crews and plans to add another in December 2011.

Pioneer had 24 MMboe in proved reserves in the Eagle Ford at the end of 2010.

### Plains Exploration & Production Co.

- *Expects to produce more than 10,000 boe/d*
- *Plans to invest \$396 million in 2012*

Plains Exploration & Production Co. bought into the Eagle Ford Shale play late in 2010, set an aggressive development program, began drilling, and raised its estimates for 2011 recoveries.

In October 2010, Plains announced its plan to acquire some 58,400 net acres, primarily in Karnes County in the oil and condensate window of the play, for \$578 million in cash. It closed that deal before the end of the year.

Some 20,400 net acres were located in a joint area of operations with EOG Resources Inc.

At the time of the announcement, Plains said it expected the properties to have a net resource potential of approximately 140 MMboe to 175 MMboe and a net production capability of some 2,000 boe/d. Under its operating plan, Plains expected to finish 2011 producing 5,000 boe/d from the properties.



James C. Flores, chairman, president, and chief executive officer, said he expected Plains to operate substantially all of the properties.

By the end of 2010, it had four rigs working the play and 12 wells awaiting completion or pipeline connection. With those wells online, it expected to produce 2,500 b/d by the end of the first quarter of 2011.

By January, Plains expected to invest \$277 million in the Eagle Ford play in 2011, \$396 million in 2012, and \$426 million in 2013. It also said it had 500 potential net drilling locations in the play and planned to run four to six drilling rigs in 2011 to go after its 175 MMboe resource potential.

In its first quarter 2011 report to shareholders, Plains said it had five rigs working the play.

It also said volumes for the quarter averaged 2,240 boe/d and it ended the quarter producing 3,000 boe/d.

Results were good enough that the company increased its year-end 2011 forecast. The 5,000

boe/d production, it said, counted on a three-rig drilling program. By raising its program to a six-rig effort, it expected to finish the year producing more than 10,000 boe/d. At that time, it had 18 wells waiting for completion or hookup to pipelines.

### Riley Exploration LLC

- *Working development wells in Karnes County*
- *Focused primarily in Eagleville Field*




Riley Exploration LLC is working development wells in the Eagle Ford Shale in Karnes County, primarily in Eagleville Field.

The private company drilled the 1H Berry horizontal well that tested flowing 1,631 bbl of 52-degree-gravity oil and 785 Mcf of casinghead gas a day from Eagle Ford fractured perforations between 12,586 and 16,672 ft.

Its 1H D&S well in DeWitt County tested for 1,379 b/d of oil and 2.64 MMcf/d of gas through perforations between 13,257 and 16,687 ft after fracturing, according to IHS Inc.

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In February 2011, IHS Inc. said the company completed the 1H Mary in Eagleville Field in Karnes County for 652 b/d of oil and 652 Mcf/d of gas after drilling to a total depth of 16,085 ft with a bottomhole location about a mile southeast of the vertical wellbore.

In adjacent Gonzales County, about five miles to the northeast, Riley's 1H Otto tested for 502 b/d of oil and 525 Mcf/d of gas.

### **Rosetta Resources Inc.**

- *Focused on an area of Gates Ranch Field*
- *Plans to complete 58 horizontal wells*

Rosetta Resources Inc. has become a big mover in the Eagle Ford play as it focuses on drilling and efficiency and invests in future profits in a concentrated area of its Gates Ranch Field.

In a July presentation, the company said it held 50,000 net acres in the Eagle Ford liquids-rich area with 20 Tcfge of hydrocarbon resource in place, 450 remaining well locations, and potential for another 441 infill drilling locations. It had completed 27 horizontal wells in the area and created net production of 115 MMcfe/d of gas.

It held another 15,000 net acres in its Encinal dry gas Eagle Ford area with 145 potential locations plus infill potential. It had completed four horizontal wells in that area and produced a net 5 MMcfe/d.

During 2011, it raised its credit line to \$750 million from \$600 million. It also closed the sale of properties in the Denver-Julesburg Basin and the Sacramento Basin for a combined \$255 million.

Those funds went into a \$360-million expenditure program for 2011, with 90% of the money allocated to the Eagle Ford.

From 27 wells completed at the end of the first quarter, it planned to complete 58 horizontal wells by the end of 2011, primarily in its Gates Ranch area, where it holds 26,500 net acres. Currently, it drills three wells to a pad with 5,000-ft laterals and 15 frac stages. The pad drilling saves the company \$500,000, per well or \$1.5 million per pad.

That kind of activity and the aggressive drilling program allowed the company to grow its production in the Eagle Ford from 7 MMcfe/d in the first quarter of 2010 to a projected 120 MMcfe/d in the same quarter in 2011.

Overall, a typical Gates Ranch well showed in initial potential of 5.7 MMcfe/d of gas and 412 b/d of oil. It offered an estimated ultimate recovery of 7.2 Bcfe and a \$13.4 million net present value before taxes and discounted at 10%, a 1.5-year payout, and a \$3.22 billion net present value for the full field.

The company also arranged rigs, frac crews, and gathering and processing capacity to handle its growing production.

### **Royal Dutch Shell plc**

- *Started producing from South Texas wells in 1953*
- *Made two major acquisitions in 2010*

Royal Dutch Shell started producing from its wells in South Texas in 1953 west of the town of McAllen, but it didn't enter the booming Eagle Ford play until it completed two massive acquisitions in 2010.

At least part of that acreage came from its \$4.7 billion acquisition of East Resources in mid-2010, but the bulk of that that buyout was in the Marcellus Shale in Appalachia.

Now, it's a strong leaseholder with some 250,000 net acres in the Eagle Ford and Pearsall plays at a purchase price of \$1 billion.

In an October 2010 presentation, the company said it had been buying Eagle Ford acreage, had started conducting a seismic survey, and started delineation drilling on its properties in advance of a development program it planned to start late in 2010 or early in 2011.

At that time, it said all of its Eagle Ford acreage was undeveloped with no production and no reserves.

In a September 2010 presentation, it said it could generate a positive net present value from the Eagle Ford at less than \$4/Mcfe and ranked it among its emerging plays, along with the Marcellus, Groundbirch in the Montney Shale in northeastern British Columbia, and Haynesville in its North American gas portfolio.

In a June 2011 presentation in Brazil, the company said it directed approximately 10% of its \$3 billion tight gas allocation to the Eagle Ford, less than it allocated for the Haynesville, Marcellus, and Groundbirch and about even with its investment in the Pinedale Anticline in southwestern Wyoming.

In June 2011, IHS Inc. listed seven wells permitted, drilling, or recently completed for Shell Western

E&P in the Eagle Ford play. Among them was the A 2H Piloncillo pilot well in Briscoe Field in Dimmit County. It drilled the pilot to a total depth of 8,255 ft in November 2010. The company did not report on cores or drillstem test results.

It also permitted development wells in the field.

### SM Energy Co.

- *57% of 2011 capital budget aimed at the Eagle Ford*
- *Total net production: 148 MMcf/d as of June 2011*

SM Energy Co. took a seemingly paradoxical position as it ramped up activity and planned to sell off properties in the Eagle Ford play, but it's a position that makes sense.

In a June presentation, SM said it planned to sell off about 15% of its Eagle Ford holdings, or about 72,000 net acres, with an emphasis on non-operated properties. Sale of those properties will give the company more control over the capital program for its operated properties, allows the company to lock in some returns, and provides SM with capital for development of its operated program.

In line with that plan, it said it would close the sale of 15,400 acres of leases for \$225 million, or \$14,610 per acre, in August. Nearly all of that acreage was in La Salle County. It had three drilled wells but had no production. It also sold off positions in other non-core properties.

Before that sale, it had 84% of its assets in its three core plays: the Granite Wash, the Bakken/Three Forks, and the Eagle Ford. It planned to ramp up activity in the Bakken/Three Forks and Eagle Ford with 57% of its \$1.08-billion capital budget for 2011 aimed at the Eagle Ford.

It held 250,000 net acres in the Eagle Ford and operated 165,000 net acres in the rich-gas window in Webb, Dimmit and La Salle counties. The remaining 85,000 acres were committed to a joint venture operated by Anadarko Petroleum Corp. in the same three counties plus Maverick County.

At year-end 2010, SM had 207 Bcfe in net reserves in both operated and non-operated properties.

Its operated properties produced 91.6 MMcf/d of gas in the first quarter of 2011, up from 19.1 MMcf/d in the same quarter a year earlier. It had three rigs at work and planned to ramp up to six rigs during the year to drill 80 gross, 70 net, wells.

At the same time, it planned to ramp up take-away capacity from a June 2011 100 MMcf/d to 250 MMcf/d in the second half of the year and to 470 MMcf/d by the first half of 2014.

On its non-operated properties, in which it held a 25% working interests with Anadarko, production at the end of the first quarter of 2011 reached 43.5 MMcf/d, up from 2.2 MMcf/d in the same quarter in 2010. Anadarko planned to keep 10 rigs working through 2011 to give SM participation in approximately 50 net wells.

SM's total net production totaled 148 MMcf/d in June 2011.

### Swift Energy Co.

- *Expanded acreage position and drilling activities*
- *About 79,000 acres prospective for the Eagle Ford*

Swift Energy Co., an old-timer in South Texas compared with the Eagle Ford land-rush companies, expanded its acreage position and drilling activities in both the traditional Olmos Tight Sand and the emerging Eagle Ford Shale.

Swift bought its first interests in AWP Field in McMullen County in 1988, became the operator of the field the following year, and continued to expand its holdings. It bought interests in Briscoe Ranch Field in Dimmit County in 2009 and continued to expand with Sun TSH (Tri Bar) Field in La Salle County and Fasken (Las Tiendas) in Webb County, along with additional properties.

In a May 2011 presentation, Swift said it had 660 Eagle Ford locations on 80-acre spacing with 4,000-ft laterals in AWP Field in McMullen County and 340 locations in Artesia and Fasken fields in La Salle and Webb counties.

#### High GOR model

	4,000-ft Model	6,000-ft Model
Per-well cost (\$MM)	7.0	9.0
EUR (Mboe)	252	354
IP (boe/d)	1,100	1,572
ROR (%)	64	74
NPV 10% (\$MM)	3.9	6.0

Rate of return figures for a liquids-rich well assume a flat price of \$90/bbl for oil and \$5/Mcf for gas. Swift properties average 77% oil, 16% dry gas, and 7% natural gas liquids. (Chart courtesy of Swift Energy Co.)



Dry gas wells in Swift inventory generate positive returns at gas prices as low as a flat \$4/Mcf. (Chart courtesy of Swift Energy Co.)

### Dry gas model

	4,000-ft Model	6,000-ft Model
Per-well cost (\$MM)	7.0	9.0
EUR (Bcf)	5.0	7.0
IP (MMcf/d)	9.2	12.8
ROR (%@ \$5/Mcf)	45	82
NPV 10% (\$MM@ \$5/Mcf)	3.2	5.5
ROR (%@ \$4/Mcf)	17	28
NPV 10% (\$MM@ \$4/Mcf)	0.8	2.2

Overall, it had approximately 79,000 acres prospective for the Eagle Ford, including 24,000 acres in the oil window, 20,000 acres in the high gas-oil-ratio (GOR) window, and 35,000 acres in the dry gas window.

It held 5 Bcfe in resource potential per dry-gas well and 250 Mboe in resource potential on a liquids-rich well for a total resource potential of 1.9 Tcfe to 3.3 Tcfe, or 310 MMboe to 550 MMboe.

The company set a 2011 capital budget of \$430 million to \$450 million, 75% to 80% of that directed to South Texas.

### Talisman Energy Inc.

- Holds 78,000 net acres
- Plans to put about 25 wells onstream

Talisman Energy Inc. is just one of a host of large companies that bought into the Eagle Ford Shale play to take advantage of high volumes of liquids-rich production.

Talisman bought 37,000 net acres in the play in May 2010. Later in the year it joined Norway's Statoil to buy 97,000 net acres of land in the play from Enduring Resources and equalized its existing properties with Statoil. The joint venture has some 1,500 well locations and approximately 1.1 Bboe in contingent resources, about half in liquids. Talisman and Statoil are 50-50 partners in the venture.

In a June 2011 presentation, the company said it held 78,000 net acres in the Eagle Ford Shale with an average working interest of about 40%.

For 2011, the company plans to put about 25 wells onstream with an average overall production of 55 MMcfe/d of gas to 65 MMcfe/d. Those wells

should provide an estimated ultimate recovery of 660 Mboe each and an average 30-day initial potential of 1,200 boe/d.

Talisman planned to ramp up from four rigs to 10 rigs during 2011 and calculated its full-cycle break-even price was less than \$4/MMBtu.

In a note to analysts Talisman said the properties produced 6.5 Mboe/d at the time of the sale, and Talisman paid a net \$10,900 an acre, or a net \$485 million, for the Enduring Resources properties. The gross sale price was \$1.325 billion.

The Canadian company will operate the joint venture properties initially but will move more to a 50-50 operating relationship over three years.

It also said three of the top 10 Eagle Ford wells were drilled on joint venture properties.

### ZaZa Energy LLC

- Houston-based private company
- Plans to acquire about 300,000 net acres

ZaZa Energy LLC waged an aggressive acquisition campaign in the Eagle Ford Shale. It's drilling wells and trying to find more land to work.

The company acquired 120,000 net acres of land in the play by November 2010. It also teamed up with a joint venture partner on 85,000 of those acres and was looking for more land.

It spud the first of six planned Eagle Ford wells that same month.

By January 2011, it had accumulated 180,000 net acres of land.

It completed the first of two Eagle Ford wells in February and spud its first well in the Lavaca/DeWitt County area in that month.

IHS Energy reported on the company's 1H Briggs Ranch in February 2011. That La Salle County well, 10 miles southwest of Cotulla, was scheduled to 16,235 ft with a bottomhole location about a mile south of the main wellbore. The well is more than four miles east-northeast of SM Energy's 1H Briggs Ranch in Briscoe Ranch Field. That well was completed in October 2010 flowing 1.98 MMcf/d of gas and 148 b/d of condensate.

The Houston-based private company set its sights on the Eagle Ford Shale with plans to acquire approximately 300,000 net acres and keep five rigs at work during 2011. ■



Caliche surrounds Nomac Drilling's Rig #116, at work on Chesapeake Energy Corp.'s Pistol Unit 1H, a horizontal well in the Eagle Ford Shale near Carrizo Springs, Texas. *(Photo by Lowell Georgia)*

# Facilitating Success

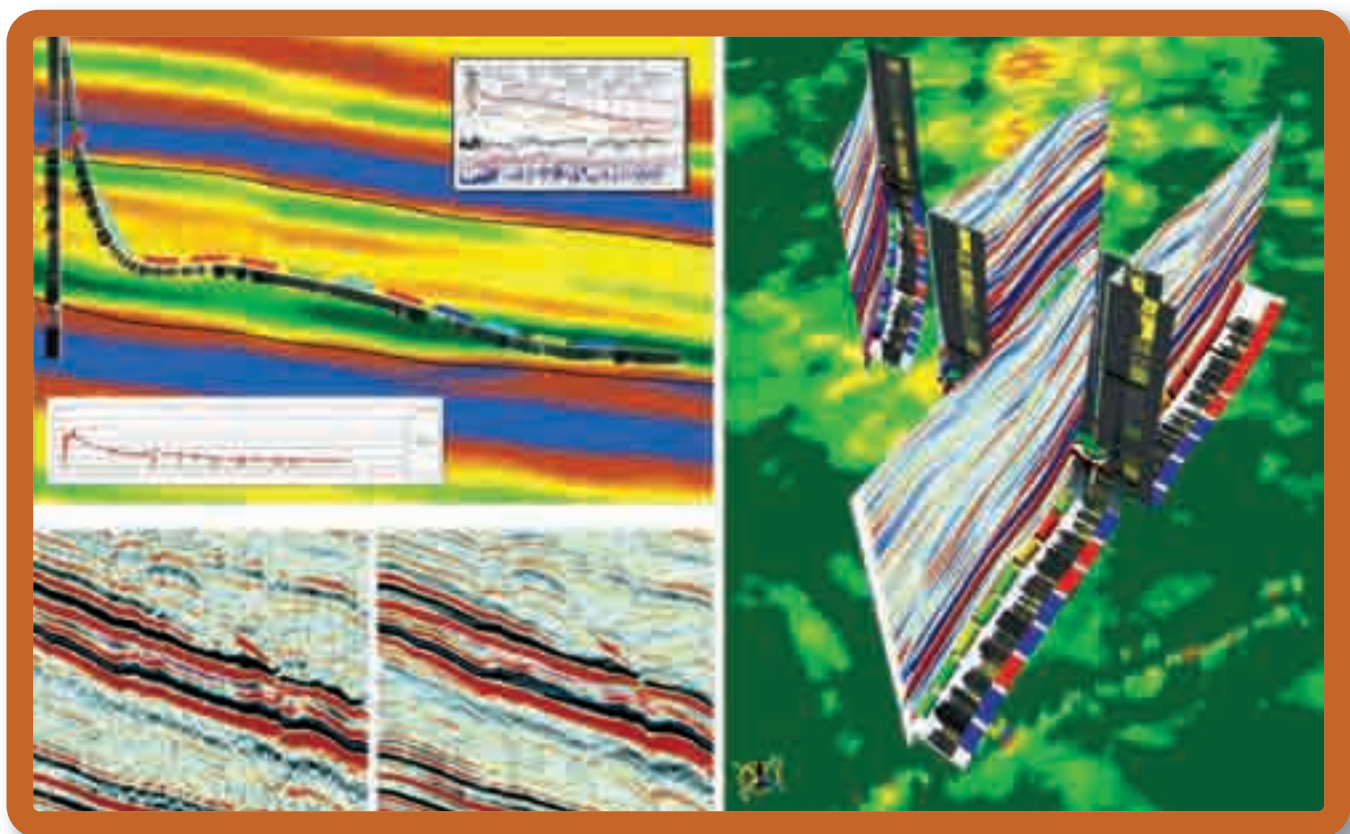
Technology is moving swiftly to improve efficiency.

**By Jerry Greenberg**  
Contributing Editor

The Eagle Ford Basin has been on the oil and gas industry's radar for some time, but exploration activity didn't really take off until a couple years ago, when operators began experiencing great success. As a latecomer, Eagle Ford has benefited from plenty of technologies proven in other

shale basins as well as new products designed specifically for the region.

Today, 3-D seismic surveys are producing vast amounts of data, too much, it seems, to be viewed and interpreted in a timely manner, much less reprocessing that seismic and other data to optimally



Top-left: Cross section along well trajectory shows acoustic impedance in the background and gamma ray well log curves with individual frac stage gas production rates. Insets represent hyperlinked data showing results from geosteering and frac operations and a daily gas production rate chart. Lower-left: Before and after seismic cross sections show the results of the PCA conditioning, which significantly suppresses the seismic noise and helps identify the internal stratigraphic complexity of the Eagle Ford. Right: 3-D cross sections along well trajectories combining amplitude seismic, gamma ray log curves, and frac stage gas production rate cylinders against a backdrop of stratigraphically sliced acoustic impedance. *(Images courtesy of Knowledge Reservoir and Petrohawk)*



place the next well bore or stimulation. Several operators are taking recently acquired 3-D data and reprocessing it to optimally place the well bore for the most productive stimulation job and later for the most productive field development scenario.

Reprocessed seismic isn't the only tool operators and service companies use to drill the best well and stimulate it as efficiently as possible. Service companies are using various formation evaluation tools, microseismic surveys, better frac fluids and proppants, and different fracture methods, including coiled tubing.

Drilling contractors also are entering the mix with proprietary software that results in their rigs drilling smoother well bores for better stimulation jobs and drilling wells faster and more cost efficiently than in the past. Drill bit manufacturers are designing better performing, more durable bits specifically for Eagle Ford, some of which have resulted in record-setting runs, including one-bit runs in the vertical, curve, and lateral sections of the well.

Eagle Ford operators seem to be the lucky recipients of successful technologies that have already been tried and proven.

### Enhanced integration

Many companies exploring in shale basins do not have the manpower or time to analyze seismic and other well and production data in an integrated workflow. The problem grows with each new batch of well or seismic data. Exacerbating the issue is that the expected ultimate recovery and total reserves of one well can be significantly different from another well only a couple thousand feet away.

"We see the same basic question coming back over and over again," said Larry Denver, president of Knowledge Reservoir. "Why is my recovery range so broad and based on that, what do I do about my upcoming drilling locations and spacing optimization? How many wells do I drill in a section?"

"Operators are all struggling with limited resources and trying to keep their heads above water, drill and hold acreage, collect the data, and get to the next well," Denver continued, "but they have very little time to do any actual analysis on the data from drilled wells and these unconventional reservoirs themselves."

To help address this need, Knowledge Reservoir is collaborating with Austin-based AGM Inc. and Houston-based Geo-Texture Technologies to interpret and integrate a batch of recently acquired Eagle Ford 3-D seismic with well and production data. AGM's Recon software supports advanced 3-D geological modeling and interpretation and is especially suited to environments requiring G&G integration with production data where horizontal wells are drilled. Geo-Texture specializes in volume-based seismic conditioning designed to reduce noise and better deliver reservoir-scale seismic attributes.

Included in their typical deliveries are acoustic impedance volumes, multi-variate attribute analysis, and curvature analysis which have been proven effective for illuminating fractures, faults, and other subtle features. The company also specializes in principal component processing to reduce noise in seismic data for better curvature computations, acoustic impedance inversion, and other post-stack processing. Seismic data should be as noise free and have the broadest bandwidth possible. With its algorithms, Geo-Texture is able to produce higher-frequency (better vertical resolution) data with less noise than the original input data. This allows interpreters to see layering and stratigraphic relationships within the Eagle Ford that are not otherwise visible.

Using the enhanced seismic as part of the integrated depth model, the operator can better understand the reservoir and where to place wells within the formation to maximize production performance. Reducing the data noise and improving the signal allow the interpreter to see more interesting rock properties.

"When we look at something such as curvature, which helps us define fracturing or perhaps brittleness or acoustic impedance, which helps to establish lithology and fluid heterogeneity, the better we can stimulate and produce the reservoir," Denver explained.

The enhanced data and improved depth-based well placement along with other frac modeling can help to tell the operator how mechanically successful the completion was and what the reservoir rock is like along the completion. The operator is then better able to determine the potential productivity of the reservoir and the completion. Hopefully, the

operator can learn why two wells that are 2,000 ft apart are so different from each other in terms of expected ultimate recovery.

In the Eagle Ford, enough wells have been drilled and enough data collected and made available to companies like Knowledge Reservoir that certain industry relationships are becoming clearer. In particular, the industry knows it must be able to more accurately characterize such properties as matrix permeability, frac length, rock brittleness, and clay content. Integrated models of geology/geophysics, well data, and production results help to do so.

"We are now testing and building a workflow to be applied to the Eagle Ford," Denver said. "Good, solid integration with workflow, ideas, and technology tailored for the particular area."

### Geosteering in the Eagle Ford

Denver emphasizes that, based on the company's observations, geosteering based solely on widely spaced-type wells and log curve matching in areas with limited well data and no seismic will be challenging in plays like the Eagle Ford, which can change rapidly in thickness, rock type, and structural dip. Compared to plays such as the Bakken, the Eagle Ford is more complicated to geosteer even though the thickness of the Eagle Ford is much greater than the target area within the Bakken.

"Until now, Eagle Ford operators have oftentimes been without the quality or quantity of data they would like to have to accurately place their wells and to be able to predict well performance," Denver said. "To help accelerate the learning curve, we believe the integrated data sets are paramount to unraveling the Eagle Ford curiosities.

"At the end of the day, even if these reservoirs are unconventional, our understanding of them will be based on the same methods we have relied on for complicated conventional reservoirs," Denver concluded.

As with completions discussed earlier, the recently available batch of seismic data is aiding in building better well models. Unlike the Barnett Shale, where operators used seismic mainly to avoid hazards downhole (don't drill into or frac into the Ellenburger or you'll produce more water than gas, for example), in the Eagle Ford, due to its complexities and quickly changing formation char-

acteristics, operators are learning how to use seismic to understand what part of the reservoir rock they want to drill.

"A Bakken approach is not going to perform as well in the Eagle Ford," Denver explained. "The formula is more complicated and includes much more than lateral length and number of frac stages.

"Given some time, our industry will eventually unravel the Eagle Ford complexities," Denver continued. "The main question to ask now is how can we get there faster and reduce our costs along the way?"

### Software for drilling efficiency

Canrig Drilling Technology Ltd. offers several software applications that improve drilling efficiency, reduce drilling time, and save costs, according to the company. Canrig, an affiliate of Nabors Drilling USA, has contracted with Shell to provide various technology products for Nabors' rigs operating onshore for Shell in the lower 48 states and Canada, including the Eagle Ford. Most of Nabors' rigs have the various software programs installed.

Canrig's Soft Torque Rotary System was patented by Shell and licensed to third parties for commercialization more than 10 years ago, according to Canrig. Shell has been working on the technology for application on all of its rigs globally. For various reasons, successful and consistent implementation has been elusive until recently. Today, many of Nabors' rigs contracted to Shell use Soft Torque as a result of Canrig's involvement.

"We are in the early stages of commercialization," said Scott Boone, vice president, Drilling Automation for Canrig. "We have installed the technology on most of the rigs for Shell and we will be commercializing it for use on Nabors rigs for other operators."

The software is designed to mitigate the effects of stick slip and downhole vibration during drilling. The result is higher rates of penetration (ROP), increased bit life, and reduced tool failure. The system integrates into a standard Canrig A/C top drive drilling system to alert the driller of excessive downhole vibration. It operates from the surface, does not require downhole equipment, and does not interrupt the drilling process. It is operated on demand from the driller's top drive control screen and can be turned on or off by the driller.

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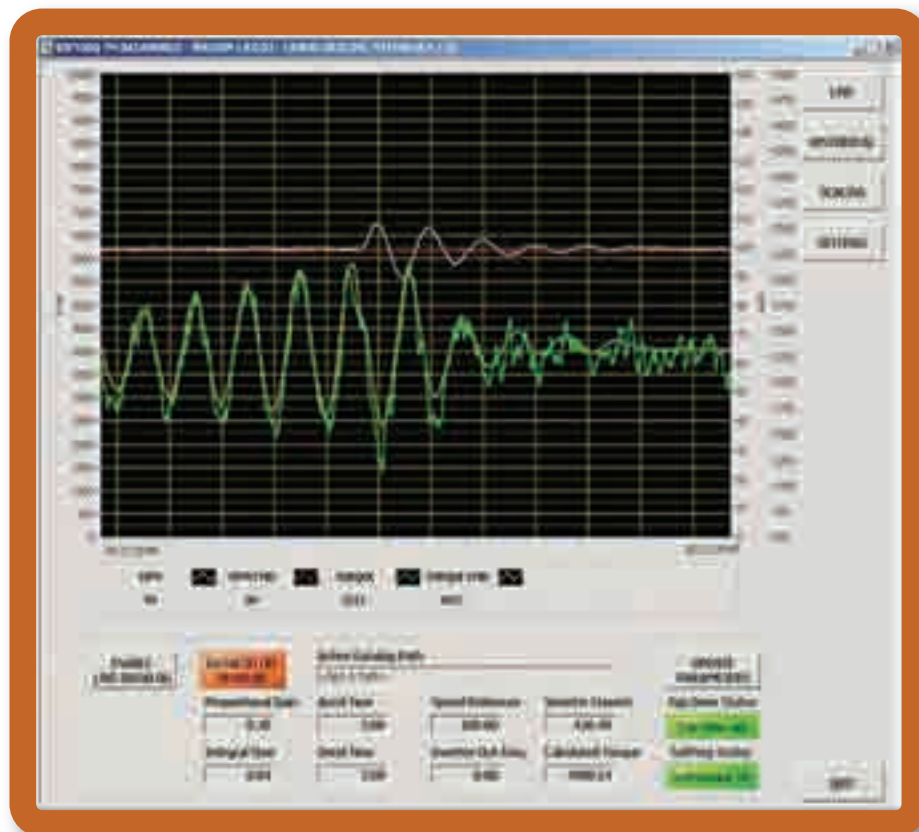
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Soft Torque software is designed to mitigate the effects of stick slip and downhole vibration during drilling, resulting in higher rates of penetration, increased bit life, and reduced tool failure. (Image courtesy of Canrig Drilling Technology Ltd.)

The system operates like a torsional shock absorber from the top drive, eliminating fluctuations in downhole bit speed. It detects stick slip and takes corrective action to resolve the problem. It is completely non-obtrusive to the drilling process, working from the top drive instead of downhole. The driller has the ability to enable or disable the system depending on the requirements of the well being drilled.

The system includes two monitors, one to help evaluate its real-time performance while the other provides historical views of data to help the driller and others evaluate the effectiveness of the system in mitigating stick slip. Additionally, Soft Torque integrates with the company's *myWells.com* software portal, allowing others to see how the tool is working from anywhere in the world.

### Directional drilling automation

The company's Rockit directional drilling automation platform provides three tools to the directional

drilling process when using motors and bent housings. The software provides three unique functions, according to the company: oscillation control, toolface orientation, and bearing offset control, all of which contribute to more efficient drilling operations. Additionally, two unique automation products can be included with the system: Heads Up Display and Rockit Pilot.

"There are three values with the Rockit system," Boone said. "Once the toolface is established, the pipe can be rocked back and forth to help break friction and provide more consistent weight on bit. Second, when initially setting the toolface, the system is integrated into the top drive, and it knows the position of the quill allowing for faster toolface setting. Third, when drilling a lateral, if the bit begins wandering the Rockit system can be used to bring it back to the correct position without coming off bottom or making changes that affect drilling efficiencies."

The software can eliminate the manual orienting of the toolface that enables the driller to steer through the well bore. Manually orienting the toolface requires considerable experience and timing, not to mention having that certain "feel." With the software, the computer controls the correct amount of rotation to maintain toolface orientation.

To control the toolface, bearing offset control allows the driller to nudge the toolface left or right while drilling, providing fine control of the toolface orientation. These adjustments can be made while drillstring oscillation is in progress.

The system can oscillate the drillstring from the surface to reduce downhole friction. The oscillation or rocking can be programmed from a fraction to several revolutions of the drillstring. The amount of oscillation right or left is adjusted by the driller to provide maximum drillstring rocking without affecting toolface orientation.

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**THINK GREEN.**

### A case study

Typical wells in the Pinedale Anticline in Wyoming have shallow kickoff points around 200 to 300 ft, followed by approximately 1,000 ft of build to a maximum inclination of 20°. The drop curve takes the well bore back to vertical, and the wells are drilled vertically to a total depth of about 13,500 ft TVD. The build curve is usually around 1,300 ft measured depth (MD) and the drop curve around 2,000 ft MD. These wells are drilled through the Fort Union and Lance sandstones of the Mesa Verde Group.

In executing these wellbore curves, the directional driller used rotary drilling and slide drilling in the intermediate and production sections when directional control was needed. To determine how the use of the Rockit software influences slide drilling performance, a comparison of sliding ROP while using the technology was compared to that of three wells drilled previously in the same area. Overall, the average sliding ROP increased from 49.83 to 75.24 ft/hr with the addition of the Rockit system.

### Understanding the reservoir

Activity in the Eagle Ford Basin began only a few years ago and, consequently, there is limited historical information, public or otherwise, about long-term well productivity. That is beginning to change,

providing an opportunity for service companies to obtain information that can verify whether their technologies and products optimized or enhanced the well and its productivity.

By implementing its Understand the Reservoir First philosophy, examining the entire reservoir package, and becoming involved with the customer at an early stage, Baker Hughes is able to zero in on the reservoir and apply the correct fracturing fundamentals required to maximize results.

“We are constantly working to optimize the success of each well and maximize initial and long-term productivity,” said Tom Royce, Baker Hughes, Pressure Pumping, South Texas Area technical manager. “We look at available production data and correlate it against how the well was treated, products pumped, and formation and area data.”

The company uses this information to further enhance subsequent treatments in the immediate area. Certain trends have evolved that provide better results, Royce noted, such as pumping larger fluid and proppant treatment volumes at higher rates and with more stages. Proppant type and mesh also can make a considerable difference.

### Long-term scale inhibitors

One solution with the potential to enhance long-term production is the BJ Sorb family of solid specialty chemicals and inhibitors. BJ MultiSorb technology allows the combination of two or more Sorb chemical products in treatments designed to address multiple problems simultaneously. In the Eagle Ford Shale, the technology has been used to treat paraffin, asphalt, and biocides, among other issues. The company also has used liquid biocides in fracture fluids and is preparing for its initial use of BJ BioSorb in the Eagle Ford.

When pumped with the proppant during the frac job, the subsequent inhibitor desorption from the Sorb solid product is relatively slow and results in more consistent and longer-term inhibition. Residuals have been measured in production fluids at effective levels more than five years after the fracture, according to the company. As a result, in many cases, it saves the operator from remedially retreating the well after the stimulation. Although the technology has been avail-



In many cases, BJ Sorb solid specialty chemicals and inhibitors can save the operator from remedially retreating a well after the stimulation. *(Photo courtesy of Baker Hughes)*



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able commercially for a number of years, it is a growing application in the Eagle Ford Basin.

### Ultra-lightweight proppant

With more favorable economics, many operators are gravitating toward oil-bearing Eagle Ford formations, which may only be a few thousand feet deep. At these shallower depths, Baker Hughes has seen significant potential for the application of their BJ LiteProp ultra-lightweight proppant, which provides improved transport properties in low- or no-polymer frac fluid systems, thus minimizing residual damage and offering greater effective frac length with maximum producing zone conductivity.

“[LiteProp] will allow us to get more proppant further into the fracture, resulting in a better distribution than we can get currently with more conventional proppants that have the potential to improve production in shallow Eagle Ford reservoirs,” Royce said.

The low-density proppant (specific gravity of 1.08) provides a more uniform proppant distribution across the entire fracture. The technology also allows the operator to adjust several variables, such as pumping rate and pressure, fluid viscosity, and proppant loading in different applications. The inherently slow settling rates can enhance proppant coverage, while the ability to use lower viscosity fluids can enhance penetration and frac height containment. Post-treatment productivity analysis of wells fractured with low concentrations of ultra-lightweight proppants indicates that a partial monolayer has been achieved.

### Optimal fracture placement

With the merger of Baker Hughes and BJ Services, technology teams within the companies began working together to develop technologies that offer the best stimulation results. These technologies include optimized fracture placement, types of treatment, and completion strategies, among others.

“When talking about spacing frac treatments, for example, the current convention is to break up the horizontal into equal increments,” Royce said. “We are starting to look at where to best place the fractures, the perforations, or ports for sliding sleeves.

“By maximizing available technologies, we can begin to determine areas along the horizontal that have greater potential production. There are some sections where we might put in more stages,” he added.

“Conversely, there may be one long stage with low potential production, so minimal treatments may be needed, or there could be sections of the horizontal that would not benefit from stimulation,” Royce continued. “The idea is to combine technologies and optimize the well.”

### Developments in coiled tubing-based fracturing

Halliburton has used its CobraMax coiled tubing fracturing service in the Marcellus and the Canadian Bakken basins with success and planned to begin using the technology in the Eagle Ford by mid-2011. The service enables placement of a virtually unlimited number of frac stages in a horizontal section with the flexibility of on-demand, downhole changes in proppant concentration.

“We have hydraulically fractured and stimulated [Marcellus and Bakken] wells with as good or better production using half the footprint, half the trucks, half the equipment, and half the personnel,” said Stephen Ingram, technology manager, Houston Business Unit and South Texas for Halliburton.

The recent development in CobraMax service combines coiled tubing-based fracturing, hydrojet perforating, and downhole mixing and enables completing multiple intervals assuring that all intervals receive the designed proppant volumes, according to the company. CT is used to hydrojet perforations and in the individual fracturing



Multiple particle sizes of BioVert NWB diverter help achieve bridging for a highly effective seal and diversion to another designed zone. (Image courtesy of Halliburton)



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treatments of each interval. The process does not require removing the coiled tubing from the well between perforating and fracturing treatments, so unplanned events such as early screen-out can be remediated immediately with minimal impact on overall completion costs and process efficiency.

The process enables managing the proppant concentration at the perforations. A downhole mixing process combines a proppant concentrate (usually 20 ppg proppant in water) being pumped down the CT with clean treatment fluid being pumped down the annulus. By managing the pump rates, a mixture of the desired proppant concentration is created downhole immediately before entering the perforations. The process also enables unique and aggressive treatment schedules such as pumping a high proppant concentration followed immediately by a low concentration (slug/sweep) to encourage diversion within the reservoir to enhance connectivity to a larger portion of the created fracture system. Proppant plugs are used at the end of each fracture treatment not only to isolate previously stimulated intervals but also to maximize near-wellbore conductivity.

The same CT and bottomhole assembly can be used to perform final wellbore cleanouts, making the system a single-trip completion operation. Treating intervals individually substantially reduces the hydraulic horsepower required, reducing the equipment footprint, the carbon emissions, and the number of personnel onsite.

### A case study

An operator in the Marcellus Basin wanted a method to fracture 30 intervals with lower risks than conventional plug and perf. Halliburton used its CobraMax service with downhole mixing in the well. The slug/sweep proppant schedule was successfully used to achieve diversion inside the reservoir. Indications of early screen-out were mitigated by high-rate, low-concentration proppant slurry overflush of perforations using downhole mixing control, allowing the treatment to continue. One early screen-out did occur and was mitigated by circulating the excess slurry to surface with a total impact on the process of less than six hours.

Hydraulic horsepower requirements were reduced to 15,000 hhp compared with 30,000 hhp required for a conventional plug and perf. Operations were conducted in a continuous process with a single trip into the well bore, leaving the completion cleaned out to TD and flowing up the casing. Time between treatments was reduced to about 40 minutes compared with four hours per stage using conventional plug and perf methods, which require a trip in and out of the well.

### Diverting agents

Halliburton has been using a biodegradable diverting agent during fracture operations in the Barnett Field and recently began using the method in Eagle Ford. The company's BioVert NWB near-wellbore temporary diverting agent is the industry's first chemical diverter proven to meet the requirements of fracturing, according to the company. The agent provides diversion by sealing perforations, then dissolving and disappearing, leaving perforations, fractures, and well bores open.

"We are using BioVert diverter in the Maverick Basin where Eagle Ford's heavier oil is located, helping operators create more effective fracture networks," Ingram said. "The diverting agent sustains higher casing tubing pressures and more sustainable production where it is challenged due to lower bottomhole pressures."

The diverting agent enables faster completion operations at lower cost by reducing the number of pumping stops during multistage fracturing. The agent can provide temporary isolation of newly stimulated perforation clusters within the treatment interval. The material has two distinct particle sizes. The larger size blocks the majority of a perforation, and the second smaller size bridges on the larger particles to reduce permeability by 95% or more. The perforations receiving the early fluid and proppant volumes of the treatment stages can be temporarily isolated, diverting further treatment to additional sets of perforations. This procedure can facilitate longer laterals, reducing the number of perforating runs and frac plugs required.

### A case study

BioVert NWB diverter had been used in the Bar-

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nett Shale prior to being introduced in Eagle Ford. During the original completion of one horizontal well in Barnett, the casing in the vertical section parted with only 50% of the stimulation program completed. When the casing was patched, it presented the dilemma of a restriction above the horizontal lateral and subsequently lowered the pressure rating for the entire casing string.

A redesign of the completion program was required since the traditional pump down plugs and perforation guns could not pass through the casing patch. The key to a successful completion was to ensure the new perforations could be isolated below the restriction. Also, any technique must function at the reduced pressure rating of the casing patch. The diverting agent was pumped in a low concentration as its own unique stage within the frac treatment.

During treatment the casing pressure dictated pumping rates, sand volumes, and diverting stages. On-site real-time evaluation of the treatment's effectiveness further optimized the sand volumes, diverting stages, and subsequent acid stages. The pressure response from one diverting stage was over 1,200 psi, more than adequate to redirect subsequent stages. Once the well was cleaned out of bridge plugs, it was brought online at production rates in the upper 10% of the wells that make up this particular production unit.

### Record-setting bit runs

"A year ago, a typical Eagle Ford well profile started with 14 3/4-in. hole, 9 7/8-in. intermediate, and then to 8 3/4-in. curve and lateral," said Guy Lefort, Halliburton's U.S. Southern Region Drill Bit technology manager. "Today, operators have moved to two-string wells with a 12 1/4-in. section and an 8 3/4-in. intermediate, curve, and lateral section."

Operators have been somewhat successful in drilling the intermediate, curve, and lateral with one bit and one bottomhole assembly.

Halliburton's Drill Bits and Services unit's FXD matrix body bits are more durable and erosion resistant than steel body bits, according to the company. "We definitely have rate of penetration [ROP] leading performance using the matrix body bit in the Eagle Ford," Lefort said. "The matrix body bit

provides durability and design flexibility advantages as its tungsten carbide copper alloy matrix is very erosion resistant and more durable, from a hydraulics standpoint."

In one record-performance run, an 8 3/4-in. FXD54 bit drilled the entire vertical, curve, and lateral in a single run, setting the field record for the fastest lateral and lowest cost per foot in Eagle Ford's Briscoe Ranch Field in Maverick County. The bit drilled 8,595 ft in a single run at an average ROP of 102.93 ft/hr. The bit drilled from the casing shoe to TD through the abrasive Olmos Formation, built the curve at 7°/100 ft, and drilled over 4,400 ft of lateral.

In another Eagle Ford well, an 8 3/4-in. FXD55M bit drilled 8,701 ft in the vertical, curve, and lateral sections at an average ROP of 91.1 ft/hr while drilling the curve and building to 10°/100 ft at 64.6 ft/hr. The bit lateral performance included 40% sliding to maintain the tight target window and recorded instantaneous rates of penetration for 210 to 250 ft/hr.

The company's Design at the Customer Interface (DatCI) program helps achieve these record bit runs. DatCI is a continuous improvement loop that uses a global network of trained Application Design and Evaluation (ADE) specialists who work directly with the customer to define application-specific bit solutions. The development process is greatly speeded and reduces the chance of misinterpreting the customer's needs.

The ADE specialists have local knowledge as well as global experience and work with IBitS 3-D bit design software to optimize the design and also provide the ADE with a direct link to manufacturing. The ADE can work in customers' offices or at the rig site.

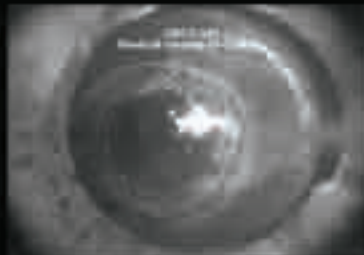
"We can fine-tune designs for specific applications such as Eagle Ford and make bit design changes quickly based on what we learn from previous runs and at the local level," Lefort explained. "We have the design specialist with the customer, looking at the bits being used, understanding any deficiencies, and improving the next bit with firsthand knowledge."

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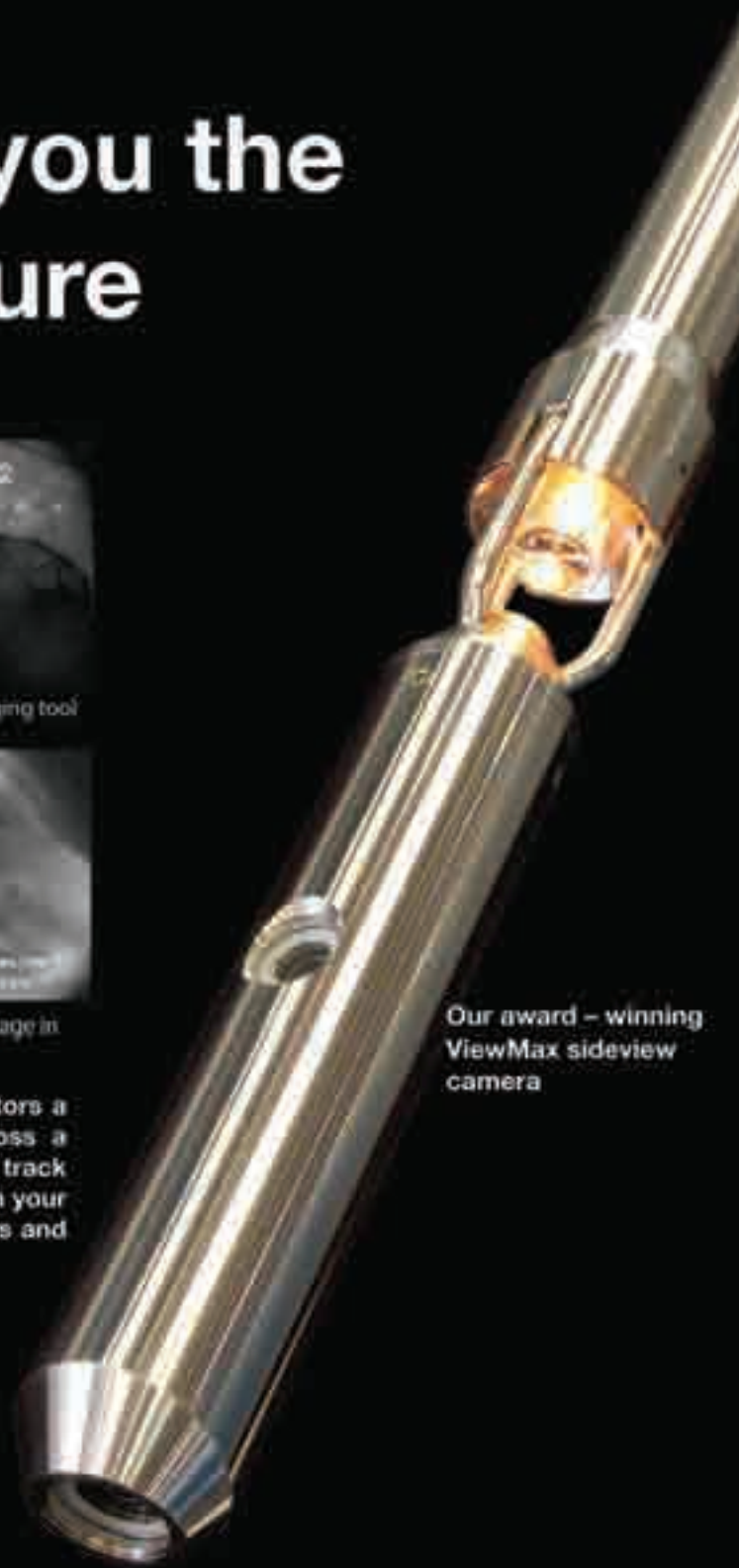


A Frac Ball creating a blockage in a HZ wellbore

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rotary steerable systems (RSS) that can kick off deeper in the well and land earlier in the reservoir, extending the productive horizontal well section. The Schlumberger hybrid PowerDrive Archer high build rate RSS combines point-the-bit and push-the-bit steering and can drill the vertical, curve, and lateral sections in one run. The tool's internal pads push against an articulated sleeve pivoted on a universal joint to point the bit. It also enables openhole sidetracking at any point in the well because of reduced dependence on wellbore contact.

It can increase ROP and deliver a smoother borehole that allows easier casing runs, more uniform cementation, and improved stimulation programs. The PowerDrive Archer has built curves at more than 17°/100 ft dog leg severity (DLS) with 8 1/2-in. bit in the Eagle Ford. With all external parts of the RSS continuously rotating, even at such high DLS, hole cleaning is improved, thus reducing the risk of stuck pipe. At press time, more than 30,000 ft had been drilled in the Eagle Ford with this RSS.

Most wells in the Eagle Ford Basin are drilled using conventional motors with a high percentage of slide intervals required to build curves up to 10°/100 ft. As a result, ROP is reduced along with the potential risk of running casing problems due to high wellbore tortuosity in the curve and lateral sections. On the other hand, continuous rotation greatly reduces micro doglegs and increases ROP by eliminating sliding intervals. In the Eagle Ford play, use of the RSS increased ROP by 85% and consequently reduced the cost per foot by 27% compared to conventional motors.

In a multiwell project, the RSS improved the average ROP in the curve, drilling 85% faster than conventional motors in 10 wells. Tortuosity in the curve and lateral was greatly reduced, and the operator found for the first time that casing could be run to bottom without rotating.

### Channel fracturing

Channel fracturing, offered by Schlumberger commercially in its HiWAY, flow-channel hydraulic fracturing technique, involves mixing fibers with proppant to create channels through the fracture network to enhance conductivity (Figure 1). Rather than leaving fracture flow dependant on proppant pack conductivity, HiWAY creates stable channels

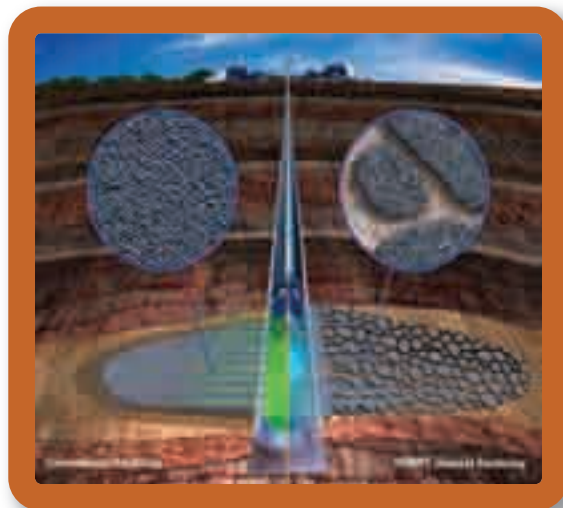


Figure 1. The HiWAY technique creates highly conductive flow channels so hydrocarbon flow is no longer limited by proppant conductivity. (Image courtesy of Schlumberger)

for hydrocarbons to flow through, increasing the effective fracture conductivity. In areas in which fracture conductivity is not limiting, HiWAY also provides for improved production by increasing the effective area of contact with the reservoir, according to the company.

“There are four items critical to the success of HiWAY,” said John Lassek, engineering manager for North America Land. “The first is a pulsing technique that we use to create the channels. On the surface we use specialized equipment to alternately pump slurry and clean fluid, and we create these pulses very rapidly.”

“Second is the fibers we use in the pulses in order to keep the fractures coherent and prevent them from homogenizing. Third, we use fit-for-purpose perforation strategies to promote creation of the channel network. Lastly, but not less important, is the geomechanical modeling that goes into understanding where this technique is applicable and where it is not.”

“Two key aspects that make HiWAY work are the addition of fibers and understanding the distance the channels are spaced,” said Matt Gillard, stimulation product line manager for North America Land. “The fibers prevent everything from collapsing and assure the channels stay in place during the closing of the fractures. The second key aspect

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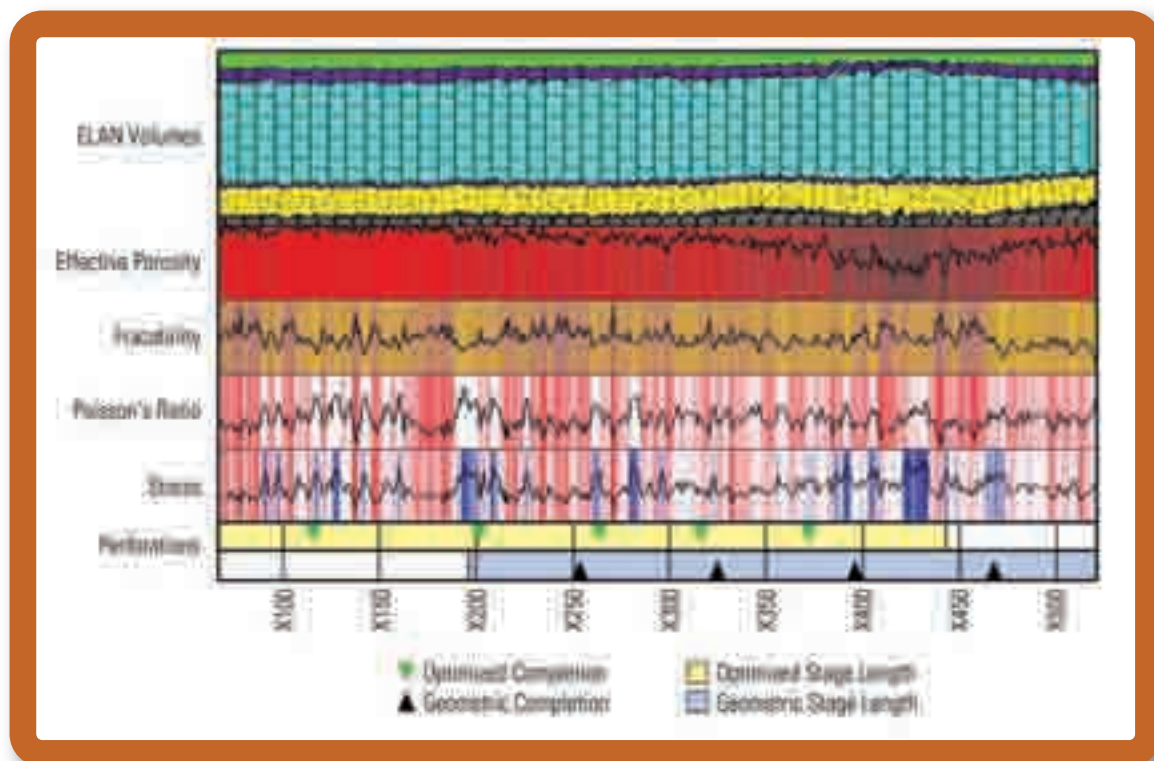


Figure 2. This image shows a composite well assessment of one stage with perforation clusters selected from a geometric completion design indicated by black triangles and optimized completion design in green. The actual positioning of the stages is represented by yellow and blue shading in the bottom row with blue being a geometrically completed stage. In this case the maximum stress difference between the maximum and minimum stressed perforation cluster has been reduced from 1527 psi to 235 psi. The ELAN volumes are an elemental analysis based on neutron, density, and resistivity measurements and show volumes of such things as clay, calcite, kerogen, and free oil. The next row is effective porosity. While there is some indication at depth x450 that the mineralogical volumes change it is quite clear from the effective porosity that there is variability. The next three rows: fracability, poisson ratio, and stress are derived from acoustic measurements and density. A geometric completion is a strictly mathematical division of the productive well section with no regards to formation changes. Note how the final row, perforations, has four evenly spaced perforation clusters placed at points of variable stress, mineralogy, and porosity. The green arrows indicate perforation points selected based on formation properties. (Image courtesy of Schlumberger)

is understanding the spacing of the channels, the width of the channels, and how that is related to the geomechanics of the well.”

The technique involves a unique combination of placement methods, materials engineering, completions techniques, and process control equipment, the company said. The stability of the flow channels is ensured by using a proprietary fiber, which maintains the structures from surface to reservoir until the fracture has closed and the *in-situ* stress of the rock takes over.

The productivity of the fracture is decoupled from the actual permeability of the proppant used,

so rather than flowing through the proppant pack, hydrocarbons flow through stable channels — meaning infinite fracture conductivity. Traditional losses in proppant pack conductivity from crushing, fines, fluid damage, multiphase flow, and non-Darcy effects are eliminated, ensuring more fluid and polymer recovery.

### A case study

Petrohawk wanted to improve production and estimated ultimate recovery from its Eagle Ford wells in the Hawkville Field. The field has very high fracture gradients and high bottomhole temperatures at depths



Figure 3. This image compares the maximum and minimum stress perforation clusters across the entire well bore. Using an optimized completion resulted in lower differential stresses gave the completions team confidence in increasing the stage length. This resulted in a reduction of three stages and stimulates a greater percentage of perforation clusters. (Image courtesy of Schlumberger)

between 10,000 and 13,000 ft. Since the discovery of this section of the Eagle Ford in 2008, the formation has been stimulated typically with multistage horizontal completions with high-rate slickwater treatments. Recently, however, there has been a trend to use polymer-base crosslinked and hybrid treatments, which led to a moderate improvement in production.

Petrohawk and Schlumberger implemented the HiWAY technique in two wells to build an assessment. Results from the two wells were compared with those from valid offsets previously stimulated by conventional techniques. The results indicated that channel fracturing gave the first well fractured with the HiWAY technique an initial rate of 14.5 MMcf/d, a 37% higher initial gas production than the best comparable offset well. The technique gave the second well a maximum initial rate of 820 b/d, a 32% higher initial oil production rate than the best comparable offset. Additional wells have been completed for Petrohawk and other companies using the channel fracturing technique, and all have shown production trends consistent with the initial test wells, according to Schlumberger. More than 800 HiWAY treatments have been performed in the Eagle Ford Shale for seven operators over the last 10 months.

### Better stimulation

“While most clients are still treating the Eagle Ford like a geometric play with 250 ft to 300 ft stages and uniformly spaced perforation clusters, some clients are beginning to design optimized completions,” Gillard said. “Using logging while drilling [LWD], real-time steering corrections can be made to assure the well stays in zone.

“Additionally, the LWD measurements can be used to group frac stages in similar anisotropic mechanical property zones or avoid swelling clays,” Gillard continued. This increases the likelihood of all perforation clusters contributing to production. A recent study of over 100 wells showed that nearly one-third of perforation clusters don’t contribute and two-thirds of production comes from one-third of the perforation clusters.

“We use LWD as a cost-effective measure to understand how the reservoir quality changes along the well bore and use that information to intelligently place the fracture stages,” Gillard explained. “We are beginning to see the implications of this method in the Eagle Ford.”

“Most of our customers want to stimulate the entire lateral but to do that effectively the rock types

have to be grouped together,” Lassek said. “So, like stresses will be together and like natural fractures will be together, among other criteria.

“We have a fairly rigorous methodology where we group like rock together and complete them at the same time to effectively complete the entire lateral,” Lassek added.

In the Eagle Ford, Schlumberger drilling technologies are provided through PathFinder, which has an extensive portfolio of tools to meet the various well evaluation needs. Real-time images for steering in the lateral well section are typically obtained from azimuthal GR or azimuthal density readings. Formation stress along the lateral and mineralogical assessment obtained through multifunctional LWD tools give lateral log type and high-resolution resistivity imaging in waterbase muds from a wide range offering of proprietary tools and technologies.

A combination of these measurements with an accurate understanding of well placement is used to derive reservoir and geomechanical properties to optimize the completion design and enhance the stimulation treatment.

### A case study

An operator drilling wells in the Eagle Ford ran LWD nuclear and acoustic tools with the intent of analyzing the impact of formation heterogeneity along the lateral. This was done with a detailed well placement model obtained through imaging, capturing standard triple combo measurements, and calculating stress variability along the well. These measurements were then used to compute reservoir properties where an optimal casing completion design consisting of multilength stages and variable perforation cluster spacing was recommended. Stages are selected such that similar rock properties are grouped in each stage. Perforation clusters are chosen based on the reservoir and completion qualities. This includes stress profile and mineralogy from formation evaluation to optimize the fracturing strategy. This optimized design would improve the overall completion effectiveness compared to conventional “geometric completions” consisting of uniform stage lengths and fixed perforation cluster spacing.

The image in Figure 2 shows an analysis of a composite log consisting of nuclear and sonic meas-

urements. The stage shown is based on a geometrically planned completion with 19 equal stages, each 284 ft in length, and four perforation clusters per stage spaced at 71 ft. The location of the perforation clusters is indicated with small rectangular squares in the perforation row. The five green arrows in the same row show optimized cluster position selected with consideration of stimulating similar stress points across each stage. Note that the stages as determined by the two selection processes begin and end at different depths, perforation clusters are slightly shifted, and there is an additional perforation cluster in the optimized casing completion design. In this case, the stress difference between the maximum stressed perforation cluster and the minimum stressed cluster in the stage is reduced from 1,527 psi in the geometric completion to 235 psi in the optimized completion. Based on similarity in stresses, the company recommended slightly larger stage lengths. This reduced the total number of stages from 19 to 16 stages.

Figure 3 shows a comparison of maximum differential stress in each stage between a geometric completion and that of the optimized casing completion design. While the differences in stage lengths make a direct comparison of each stage impossible, it is clear that small adjustments in the perforation cluster positioning significantly reduce stress variation across perforation clusters in a well bore. This method eliminates large differential stresses during completion of each stage and stimulates a greater percentage of perforation clusters.

### Fracology program

Exploration of the Eagle Ford Shale is fairly recent, having taken place in just the past couple years. “The jury is still out on the evolutionary process that takes place to determine what frac method is the best to apply to deliver the maximum production from the reservoir,” said Frank Zamora, director of Chemical R&D for Weatherford. “Most of the companies are not doing pre-frac or post-frac due diligence to accurately analyze if one method had better results than another method.”

“Eagle Ford is complex and difficult because, first, it is a carbonate-based reservoir as opposed to



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quartz or clay-based reservoirs in other shales,” said Ray Miller, area engineer, South Texas for Weatherford. “Second, there are three different layers: an upper area that produces oil, a middle section that produces condensate and wet gas, and the deepest section that produces dry gas.

“The reservoir also is non-uniform and not a basin-type pattern, with several up dips and down dips,” Miller continued, “and the thickness varies dramatically. The assumption that it is homogeneous rock and homogeneous thickness along the horizontal is a wrong assumption.”

To assess the entire stimulation process, Weatherford uses its Fracology concept whenever it can. The goal of the concept is to gain as much information as possible to determine the best stimulation operation and the optimal frac placement, including using microseismic, real-time mud logging, laboratory analysis, and pressure measurements during and after the job to gain a better understanding for the next frac.

Fracology’s four steps are evaluate, analyze, execute, and verify.

The first step is formation evaluation involving geochemistry to determine organic richness; analysis of shale properties to measure porosity, permeability, mineralogy, and other rock properties; desorption and adsorption to identify gas content, quality and storage capacity; and rock mechanics to determine the mechanical strength, Young’s modulus, Poisson’s ratio, and proppant embedment characteristics.

When drilling has begun, wellsite services, the second step, becomes an integral part of the infor-

mation loop. Wellsite services employ a variety of analytical tools including source rock analysis to measure available hydrocarbon content, potential hydrocarbon generation, total organic content, and thermal maturity and to aid in kerogen typing as well as conversion. Mud gas analysis characterizes formation gas samples from the surface in real time. The empirical data from these tests helps

to determine hydrocarbon fluid types and contact points, identify pay zones, support geosteering, determine reservoir characterization in horizontal wells, and inform well placement and completion operations based on brittleness.

When it’s time to execute the fracture, the process can be fine-tuned for maximum hydrocarbon yield. Armed with data from the well site and continuous microseismic feedback, frac crews can plan the optimal fracture design and respond to geological structure complexities and changing stress conditions as the fracture operation proceeds.

In the final step, verification, real-time microseismic data gathered during fracing operations and in-treatment-well microseismic surveys conducted on pilot wells can be used to not only monitor reservoir behavior but also to adjust fracturing parameters on the fly for optimum results. The data provides detailed information about the quality of the completion and provides the only 3-D view of a well’s drainage network.

Microseismic surveys form the key technology for maximizing the economic development of an unconventional reservoir. They can identify unexpected fracture behavior and reduce the cost and time of fracing operations. Microseismic can lead to higher production rates, lower decline rates, and less water incursion. The company’s microseismic monitoring service produces fracture maps and can “see” fluid-front movements during production. The monitoring service can also result in hydraulic fracturing mapping, enhanced recovery operations, carbon capture and storage, and production monitoring, among other applications. ■



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# Transforming South Texas' Midstream

Today's short-term infrastructure constraints for liquids, gas liquids, and gas will be eliminated by mid-2013, and operators should then be able to receive full value for the majority of their products.

**By Skip Simmons**  
Contributing Editor

**T**he Eagle Ford Shale play spans 400 miles from the Mexican border up into some eastern Texas counties. The source rock in South Texas – where most of the development activity is occurring – has different maturity levels, with three distinct area development windows for oil, condensate, and dry gas corresponding to the shallow, intermediate, and deeper parts of the play, respectively. For the short term, activity has slowed somewhat in the dry gas zone in favor of development in the condensate-rich part and the eastern part of the oil zone, primarily due to the returns that producers can realize for oil and liquids relative to their dry natural gas counter-

part. This trend is expected to continue with the current overall US natural gas supply/demand balance forecasts and resultant forward gas price path. In some areas, value from condensate produced along with natural gas is helping those overall economics and is keeping development gas efforts on track, but in general, the true gas-only development potential must await more favorable market conditions.

In mid-2010, the upstream development of the liquids-rich portion of the Eagle Ford play took off, with the epicenter in Karnes and Gonzales counties. Following the successes in those two counties, operators concentrated their efforts on the liquids-rich

The production-to-market pipeline connection point on Chesapeake's Brownlow #1H.  
*(Photo by Lowell Georgia)*



Facilities	Operator	Origin/Anchor shipper	Terminus	Capacity (b/d)
<b>Truck terminal, 15,000 bbl (storage) and Catarina Pipeline</b>	Velocity Midstream	Catarina Terminal/Rosetta Resources and others	Gardendale Hub	50,000
<b>65-miles of 12-in. condensate gathering pipeline</b>	Velocity Midstream	Webb & Dimmit counties/Shell Western E&P	Velocity's Gardendale Hub, consisting of trucking, rail, and pipeline connections, and 100,000+ bbl of crude/condensate storage.	150,000
<b>Rail loading facilities</b>	US Development Group	Gardendale Hub	Various locations by rail, including St. James, La.	40,000
<b>(New) 140-mile crude/condensate pipeline</b>	Harvest Pipeline	Gardendale Hub/Shell Western E&P	Martin Midstream terminal at Corpus Christi	100,000
<b>Port of Corpus Christi new marine terminal and pipeline</b>	Martin Midstream	("Contract with major integrated oil company")	Martin Midstream terminal at Corpus Christi	300,000 bbl storage
<b>(Proposed) 70-mile 12-in. condensate pipeline</b>	NuStar Energy/ Velocity Midstream	Gardendale, Texas, hub	Three Rivers, Texas, with connection to a new storage terminal and to NuStar's existing 16-in., 200,000 b/d pipeline to its Corpus Christi North Beach terminal	100,000

Table 1. Crude/Condensate Facilities, Gardendale, Texas Area. (Tables by Hart Energy)

portions along the so-called geological border between the condensate and oil zones located in Dimmit, La Salle, McMullen, and Live Oak counties. Since March 2011, activity has also increased in Frio, Atascosa, and Zavala counties, which lie exclusively within the oil zone. Some of the larger operators in the Eagle Ford play are Anadarko, Apache Corp., Chesapeake Energy, ConocoPhillips, EOG Resources, Forest Oil, Marathon, Newfield Exploration, BHP Billiton Petroleum, Pioneer Natural Resources, Rosetta Resources, Shell Western E&P, and SM Energy. Many of these producers have made contract commitments to anchor new regional midstream infrastructure projects to support their short-term and long-term development needs.

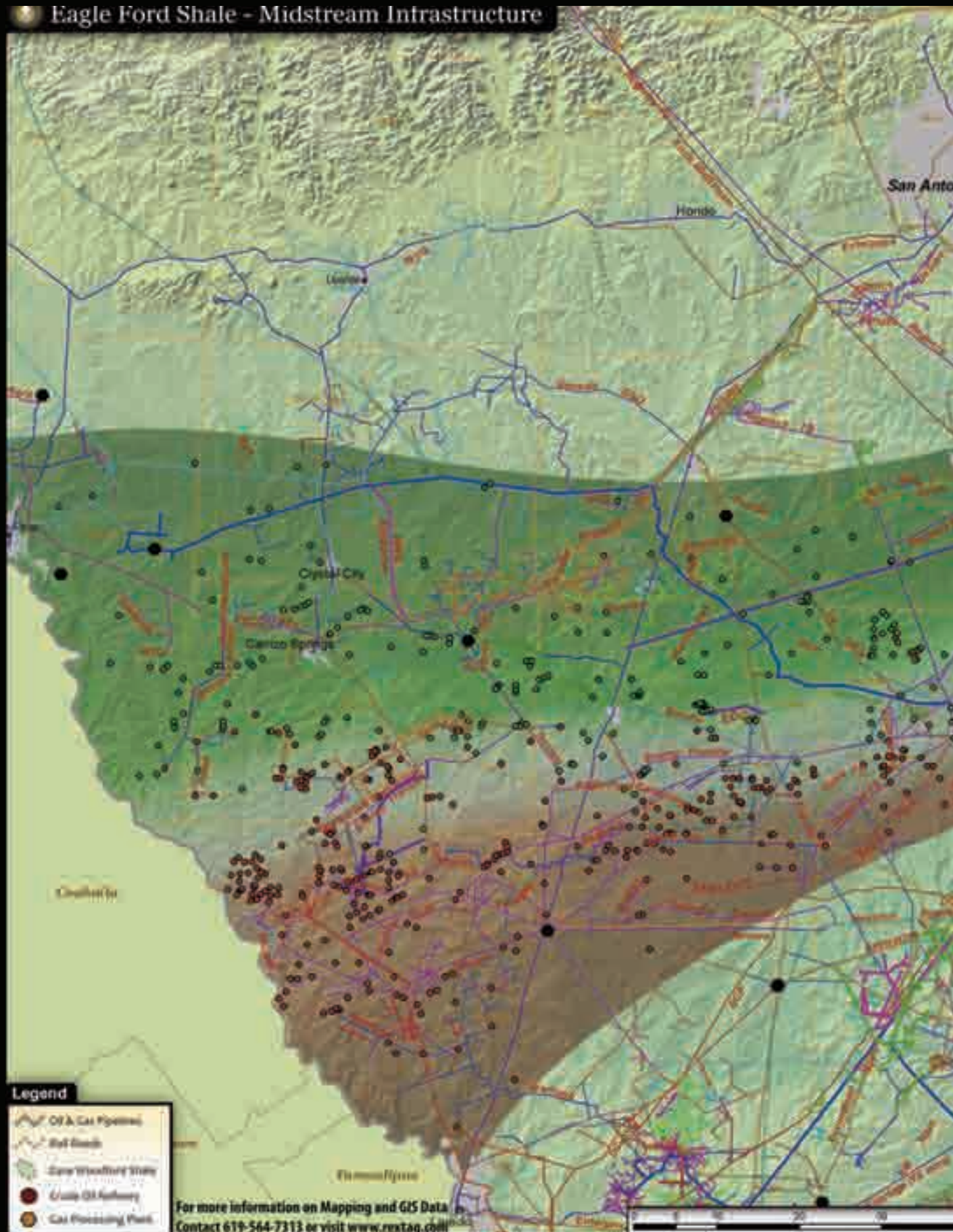
### Eagle Ford midstream infrastructure

Development efforts in the Eagle Ford Shale areas continue to ratchet upward, providing ample need for use of existing area midstream facilities as well

as triggering significant new midstream infrastructure needs. With crude oil, condensate, associated (i.e., hydrocarbon-rich) gas, and traditional dry gas all present in the developing product mix, numerous projects are being implemented to provide needed gathering capacity and access to downstream markets. In many cases, truck and rail services are currently providing for interim movement of crude oil and/or condensate production until near-term and longer-term pipeline infrastructure becomes available. Existing natural gas facilities are being used where possible to manage any gas production until long-term arrangements can be implemented. Looking ahead, many of today's short-term infrastructure constraints for liquids, gas liquids, and gas will be eliminated by mid-2013, and operators should then be able to receive full value for the majority of their products.

Natural gas gathering systems implemented by producers to support their initial well development



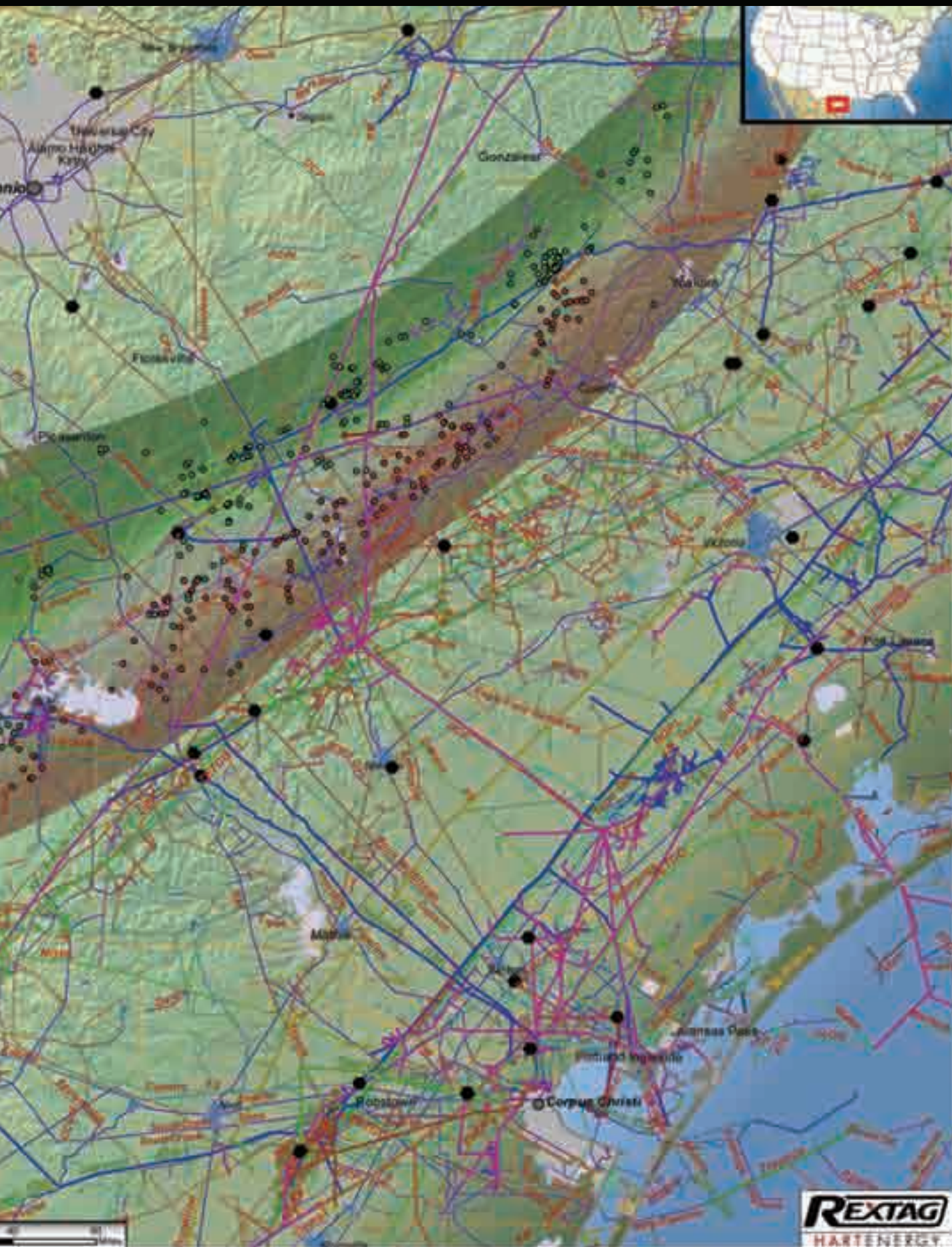


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Facilities	Operator	Origin/Anchor shipper	Terminus	Capacity (b/d)
<b>Phase 2, 80-mile crude gathering system (2013)</b>	EPP	Gardendale Hub/ Chesapeake Energy Marketing	Lyssy station, Wilson County, Texas	200,000
<b>Phase 2 crude oil terminal and storage (2013)</b>	EPP	Gardendale Hub	Lyssy station, Wilson County, Texas	500,000 bbl (storage)
<b>Phase 1, 143 miles, 24-in. crude transportation pipeline (2012)</b>	EPP	Lyssy station, Wilson County, Texas/EOG Resources	Rancho Pipeline terminal, Sealy, Texas	360,000
<b>Phase 1 Crude oil terminal and storage (2012)</b>	EPP	Eagle Ford Crude Oil Pipeline	Rancho Pipeline terminal, Sealy, Texas	2,200,000 bbl (storage)
<b>Katy pump station expansion + 750,000 bbl storage at downstream crude terminals (2012)</b>	EPP	Rancho Pipeline terminal	Houston area refineries	360,000

Table 2. Enterprise Products Partners' (EPP) Eagle Ford Crude Oil Pipeline and Related Facilities

programs have connected where possible into existing area pipeline infrastructure until longer term infrastructure is in-place to provide maximum recoverable value. In some cases, pipeline operators have been encouraged to convert existing gas systems from their traditional dry gas service mode to perform future rich gas or condensate service. The multifaceted impact of the Eagle Ford Shale development is so significant that the entire South Texas gas pipeline, NGL pipeline, and crude oil pipeline networks will be transformed into a new mode of future operations.

### Crude oil/condensate pipelines

As a result of significant discoveries in the oil- and condensate-rich portions of the play, existing crude oil pipeline infrastructure was determined to need major modification and/or expansion. Significant also was the need for these products to be gathered and aggregated and thus able to reach definitive points of further distribution or direct access to

markets. Many of these projects involve new infrastructure to gather crude either into existing area pipeline infrastructure or into new or expanded infrastructure. As such, a number of differing pipeline and terminal projects are under way to meet these requirements.

Valero Energy and Harvest Pipeline are building a crude oil pipeline from Atascosa and Live Oak counties to connect directly to Valero's existing Three Rivers refinery; the pipeline is expected to be in service by December 2011. Valero's refinery has been using primarily foreign (imported) crude in the past; Eagle Ford crude is already beginning to replace such and most likely will become the principal crude source. Total refinery capacity, post-expansion, is 100,000 b/d. Initial capacity of the new gathering pipeline will be 50,000 b/d with expansion capability to 70,000 b/d.

El Paso Midstream Energy Partners (EPM), as a part of its proposed Camino Real Pipeline concept, is oper-

ating 70 miles of crude oil gathering facilities in LaSalle County. Capacity of the facilities is 80,000 b/d; two oil terminals will provide truck-loading capabilities, and the system also can provide for on-lease loading. Currently under construction, service is anticipated in fall 2011. Connections to other oil pipelines in the area will be driven by customer requests.

A crude oil storage and transportation hub is developing in the vicinity of Gardendale in LaSalle County. A large number and variety of projects have been proposed in the area, and several have reached commitment and/or construction stage. These facilities include crude oil gathering pipelines, truck and rail terminals, local storage, and an export pipeline and storage terminal at Corpus Christi. An additional pipeline will connect the Gardendale Hub to a terminal at Three Rivers, where existing crude oil pipelines currently route to Corpus Christi as well. These projects are highlighted in Table 1.





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Facilities	Operator	Origin/Anchor shipper	Terminus	Capacity (MMcf/d)
<b>Eagle Ford Gas Gathering : 117-mile upstream pipelines</b>	EFG	McMullen, LaSalle, Dimmit, and Webb counties/ SM Energy, Petrohawk, Rosetta Resources	KM Texas' Laredo-to-Katy Pipeline	500+
<b>KM Texas Pipeline (pipeline upstream of Houston Central Plant converted to rich gas service)</b>	Kinder Morgan	EFG is the shipper on the KM Texas Pipeline System	Copano Houston Central Processing Plant and fractionators; EFG crossover pipeline to KM Tejas Pipeline System	600
<b>KM Tejas' Agua Dulce-to-Markham Pipeline (pipeline upstream of Markham storage converted to rich gas service)</b>	Kinder Morgan	EFG is the shipper on the KM Tejas pipeline system	Williams' Markham, Texas, plant	375
<b>EFG Crossover project – 56 miles 24-in. pipeline</b>	Kinder Morgan (for EFG)	Connects KM Katy-to-Laredo Pipeline to KM Tejas Agua Dulce-to-Houston Pipeline System	Crossover pipeline	375
<b>10 miles 20-in. pipeline</b>			Processing/fractionation connections	200
<b>7-miles 20-in. pipeline</b>			Formosa Hydrocarbons plants at Pt. Comfort, Texas  Williams Markham, Texas, plant:	200

Table 3. Eagle Ford Gas Gathering's (EFG) Integrated Gas Gathering, Gas Processing, and NGL Transportation Facilities

Separately, anchor shipper Anadarko Petroleum has completed long-term arrangements with Harvest Pipeline to extend the existing Arrowhead crude pipeline system to Cotulla in LaSalle County. This new 12-in. pipeline will have initial capacity of 50,000 b/d and ultimate capacity of 90,000 b/d. From Cotulla, the crude will route via a joint Koch Pipeline/Arrowhead tariff to Corpus Christi via either a reactivated NuStar Crude Pipeline, wherein Koch has leased 30,000 b/d of capacity, or via the existing and/or expanded Koch Pettus-to-Corpus Christi Pipeline System.

Koch Pipeline Company LP, the largest crude oil pipeline operator in South Texas, has an existing crude oil pipeline from Corpus Christi to Pettus. For

capacity to ship via barge up to 200,000 b/d of liquids to other Gulf Coast markets.

Enterprise Products Partners is currently one of the largest midstream infrastructure players in South Texas. To date, its principal involvement has been in the natural gas gathering, processing, and NGLs business. With a significant oil play developing in the Eagle Ford, Enterprise decided to enter that arena in a big way. Phase 1 of its Eagle Ford Crude Oil Pipeline will consist of 143 miles of 24-in. pipeline from Wilson County to existing crude facilities near Sealy. Completion is expected by mid-2012 with a capacity of 360,000 b/d. This project would also include a pump station expansion on the existing Rancho Pipeline at Katy and an additional 2.2 million b/d of crude stor-

2011, Koch reported that it had various projects that added more than 140,000 b/d to its South Texas crude oil gathering capability. In response to continuing area need, Koch Pipeline will expand its Pettus-to-Corpus Christi Pipeline to move an additional 120,000 b/d of Eagle Ford crude oil by late 2012. On the Corpus Christi end, Koch is also building a new pipeline from Corpus Christi to its affiliate Flint Hills Resources' Ingleside waterborne terminal to increase its capability. Service is expected to begin by mid-2012. The completion of the Ingleside Pipeline is timed with Flint Hills Resources' upgrades to its marine terminal that will have the

age capacity at Sealy. This project also includes 95 miles of crude oil gathering pipelines along its route to gather crude oil into the system as well as several truck loading terminals.

Phase 2 of the project would originate at the southern terminus of the Phase 1 segment and extend further to the southwest to a site near Gardendale. At Gardendale, a developing crude/condensate aggregation point, Enterprise also has planned 500,000 bbl of storage. Whereas other facilities at Gardendale are being implemented to transport crude oil into the Corpus Christi area to access markets there, Enterprise would route a portion of the area's crude/condensate to Houston Ship Channel markets. The Phase I project will begin service by the second quarter of 2012; Phase 2 is set to commence service in the first quarter of 2013. Table 2 provides detail on the numerous crude oil implementations proposed by Enterprise.

Plains All American Pipeline LP announced that it has entered a commitment to construct a new 130-mile crude oil and condensate pipeline from the western portion of the Eagle Ford play and a marine terminal facility in Corpus Christi, with 1.5 MMbbl of storage capacity. Chesapeake Energy Marketing Inc. will be the anchor shipper for the project. Chesapeake and Koch affiliate Flint Hills Resources, which operates a 300,000-b/d refinery complex in Corpus Christi, both have options to participate in ownership. The project is expected to be in service in the fourth quarter of 2012 with up to 300,000 b/d of capacity.

As a part of its purchase of a 25% interest in Petrohawk Energy's natural gas gathering and treating business in the Eagle Ford area, Kinder Morgan Energy Partners agreed to provide a 300,000-b/d crude/condensate pipeline from the Eagle Ford area directly to the Houston Ship Channel markets. To accommodate this, Kinder Morgan proposes to build 61 miles of new pipeline

to the Black Hawk Field near Cuero and would agree to convert 109 miles of existing Kinder Morgan Texas Gas Pipeline to the Deer Park area of the Houston Ship Channel from natural gas service to liquids service. Initial deliveries would be made to various terminals and facilities in the immediate Ship Channel area. The new pipeline and proposed modifications are proposed for service by mid-2012.

In the Eagle Ford gathering area, the Kinder Morgan/Petrohawk (now BHP Billiton) joint venture will be operating more than 280 miles of natural gas gathering assets and approximately 112 miles of condensate gathering assets by year-end 2011.

NuStar Logistics LP and TexStar Midstream Services LP have announced their intent for TexStar to build and operate a new 65-mile, 12-in. pipeline for gathering up to 120,000 bbl/d of crude oil and condensate from Frio County and routing to NuS-

Facilities	Operator	Origin/Anchor shipper	Terminus	Capacity (MMcf/d)
<b>Trunkline Gas 20-in. gas pipeline conversion to wet gas service</b>	Trunkline Gas	La Gloria, Texas/ DCP Midstream	Edna, Texas	up to 1,000* (estimate)
<b>130 miles of DCP gathering and connections</b>	DCP	various	Trunkline Gas converted system	300-400 (estimate)
<b>Existing processing plants</b> <b>LaGloria, Gulf Plains, Three Rivers, Wilcox,</b>	DCP	various	various	up to 1,000 (estimate)
<b>Eagle processing plant (2012)</b>	DCP	Trunkline Gas system – various connections	Edna, Texas	200
<b>Sand Hills NGL Pipeline (2013)</b>	DCP	Permian area/Eagle Ford area plants	Targa Resources fractionator and storage. Mont Belvieu, Texas	120,000 b/d
<b>Fractionator expansion</b>	Targa Resources		Mont Belvieu, Texas	100,000 b/d

Table 4. DCP Midstream's (DCP) Integrated Gas-Gathering, Gas-Processing, and NGL Transportation Facilities. \*Depending on where gas is received into the system and which plants are used.

tar's existing crude oil terminal at Three Rivers. This system would handle both sweet and sour crude as well as condensate. TexStar will also operate at least two truck loading facilities along the route to receive additional crude. At Three Rivers, connection would be made to NuStar's existing 16-in. crude oil line into Corpus Christi, which will have an ultimate delivery capacity of 200,000 b/d. Implementation is expected in mid-2012.

### **Crude – trucking and rail**

Republic Gathering & Marketing LLC announced that it has signed an exclusive joint venture agreement with Palletized Trucking to effectively transport crude out of the Eagle Ford Shale and reliably bring it to market. Republic expects to purchase and transport 600,000 bbl per month by the end of 2011.

US Development Group's Gardendale/Eagle Ford Crude Terminal is nearing completion. Located near Cotulla on Union Pacific Railroad's main line between Laredo and San Antonio, the terminal is designed to handle crude oil, condensate, and other related products. The terminal, which is 80 miles south of San Antonio, should be completed in July. Eagle Ford Shale producers in this area – who currently do not have access to crude oil pipelines – will be able to ship their products via rail and truck and, later, by pipeline. The terminal's rail operations will have the maximum capacity of 40,000 b/d. A primary market for the exported crude to date has been USD's crude terminal in St James, La. other Gulf Coast refining and chemical companies can be accessed as well.

EOG Resources has advised that it is using a crude-by-rail facility to export crude prior to long-term pipeline availability. The facility is currently transporting 4,000 b/d (1Q, 2011) and is expected to be moving 20,000 b/d of Eagle Ford oil by rail by year-end 2011. EOG advises that the concept is the same as its highly successful Bakken crude-by-rail program, where it is moving an average of 40,000 b/d.

### **Rich natural gas transportation, natural gas processing, and NGL-related facilities**

As in the crude oil transportation sector, there are a number of unique regional projects for gathering and processing Eagle Ford natural gas and han-

dling related NGL products. In general, project proposals are of two types: first, where the rich natural gas streams are integrated into relatively proximate existing and/or expanded South Texas gas and liquids infrastructure and, second, where gas volumes are routed to distant plants and thus may precipitate infrastructure expansions en route. In general, targeted NGL markets are along the Texas coast, as are the numerous NGL fractionators and storage. The largest market and significant fractionation and storage capability exists at the NGL trading Hub at Mont Belvieu at the Houston Ship Channel.

Via an additional 58-mile, 24-in. pipeline, Copano Energy will connect its existing 38-mile, 24-in. DeWitt-Karnes (DK) Pipeline to its Houston Central Plant. The pipeline extension will increase the capacity of the DK gathering system from 225 MMcf/d to 350 MMcf/d and is expected to begin service in the 4Q 2011. Copano has announced it will expand its processing capability by 400 MMcf/d to a total of 1.1 Bcf/d, and it will restart its local NGL fractionator with a capacity of 22,000 b/d of NGL products. NGL products will be delivered into existing liquids pipelines connecting to the Houston Central Plant. Start-up of the new processing plant in early 2013 will coincide with Copano's agreement to enter into a long-term contractual arrangement with Formosa Hydrocarbons at Point Comfort, where Formosa would provide to Copano gas processing capacity for 200 MMcf/d and additional fractionation capability.

Kinder Morgan Energy Partners (KM) and Copano Energy LLC have entered a multi-faceted joint venture arrangement that provides for gathering upstream gas from producers and routing it via new and existing pipeline facilities to Copano's Houston Central Gas Processing Plant near Sheridan and to two other area processing plants where Copano has contracted for added capability and flexibility. The joint venture, Eagle Ford Gathering LLC (EFG), will contract for all of the transportation capacity and the various processing plant and fractionation capacities and will be able to offer a full-service, bundled option to its customers. Contracting for all of the capacity also provides a significant degree of flexibility for EFG as to how and where it has the gas processed or fractionated.



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After conversion of a portion of the KM Texas Laredo-to-Katy Pipeline from dry gas to rich gas service, the modified gas transportation system will provide the ability to transport up to 600 MMcf/d of Eagle Ford gas, with 375 MMcf/d routed northward to the Houston Central Plant and another 225 MMcf/d routed eastward to the KM Tejas Agua Dulce-to-Markham Pipeline, a portion of which will also be converted from dry gas to rich gas service. Utilizing the modified portion of the KM Tejas system, rich gas can be routed to Williams Partners' Markham Processing Plant (capacity of 100 MMcf/d and an option for up to 200 MMcf/d) or to Formosa Hydrocarbons' Processing and Fractionation Plant (200 MMcf/d). The nearby Formosa Plastics Plant is also a consuming market for NGLs. Table 3 provides a listing of the numerous facilities required to put this joint venture arrangement into play.

In the Eagle Ford area, DCP Midstream is developing an integrated project that will provide gathering, processing, fractionation, and marketing services for numerous producers, including ConocoPhillips, Enduring Resources, Murphy Oil, BHP Billiton, Riley Exploration, and the Pioneer JV, a joint venture arrangement between Pioneer Natural Resources, Reliance Eagle Ford Upstream Holding LP, and Newpek LLC (collectively, the Pioneer JV). DCP will be constructing 130 miles of pipelines to integrate these producers and others into their arrangement. Providing the central trunk for this system will be a 165-mile portion of Trunkline Gas' existing interstate gas pipeline system, which will be converted to rich gas service. DCP's five existing area gas processing plants have capacity currently available to process up to 250 MMcf/d of Eagle Ford gas. DCP would also add a sixth plant, the Eagle Processing Plant, with 200 MMcf/d of added capacity, which is expected to be in service by late 2012. Total processing capability in the region for DCP would be approximately 1 Bcf/d. NGLs would be routed either through DCP NGL pipelines in the area already connected to existing plants or via the proposed Sand Hills NGL Pipeline described below.

Combining NGL pipeline growth needs in the Permian Basin area with those of its facilities in the Eagle Ford area, DCP Sand Hills Pipeline is a pro-

posed new 700-mile y-grade NGL pipeline from various DCP and Targa Resources Partners plants. DCP is currently seeking to secure transportation commitments from interested parties, with a proposed mid-2013 implementation and a target capacity of 120,000 b/d. Targa Resources Partners would propose to expand its fractionators at its Cedar Bayou/Mont Belvieu facilities by 100,000 b/d to provide NGL fractionation and as well as storage services. This expansion would bring the total fractionation capacity at the Cedar Bayou facilities to 393,000 b/d. Table 4 provides a listing of these various DCP facilities.

Energy Transfer Partners LP (ETP) is another company that has offered a variety of infrastructure solutions for Eagle Ford producers. In late 2010, ETP began providing gathering and processing services for Eagle Ford shippers via a new 50-mile, 350 MMcf/d Dos Hermanos Pipeline originating in Webb County and routing to a connection with ETP's existing Houston Pipeline (HPL) System. This action has facilitated immediate processing capability of limited volumes at ExxonMobil's King Ranch Processing Plant, where resultant products could be managed within existing natural gas and NGL facilities already available there. A second project scheduled for mid-2011 implementation provided for ETP to build an 83-mile pipeline from Dewitt County to ETC's existing LaGrange Processing Plant where, once again, existing natural gas and NGL facilities were already in place to manage product output. Initial capacity of this pipeline is 100 MMcf/d with the ability to increase to 300 MMcf/d.

Expanding upon these arrangements, ETP announced it will construct a major natural gas gathering pipeline, a large processing plant, and additional facilities. Supported by contracts with Rosetta Resources, SM Energy, and Anadarko, the 160-mile, 30-in. Rich Eagle Ford Mainline (REM) will have a capacity of 400 MMcf/d with the ability to expand to 800 MMcf/d. This rich gas gathering system, expected to be in service by the fourth quarter of 2011, will originate in Dimmitt County and extend to the new Chisholm Pipeline, providing deliveries to ETP's existing LaGrange Processing Plant and/or to a new 600

MMcf/d processing plant to be located in Jackson County.

This new processing facility would be operative by early 2013. Supporting the new Jackson County plant, ETP announced that it will build a 130-mile NGL pipeline to Mont Belvieu, where Lone Star NGL LLC, a joint venture between ETP and Regency Energy Partners, will construct a new 100,000 b/d fractionator at Mont Belvieu and additional y-grade storage facilities to complement its existing 43 MMbbl of NGL storage capacity. These facilities will all be in service by early 2013.

Regency Energy Partners will provide NGL to the pipeline project as well.

Finally, with intent to provide synergies to this developing network of NGL facilities, Lone Star NGL LLC will collect y-grade volumes in West Texas and build a 530-mile NGL pipeline from Winkler County to the Jackson County plant to access the

Lone Star NGL pipeline to Mont Belvieu. Thus, NGL y-grade from plants in the Permian Basin can be routed eastward and be integrated with y-grade from the new Jackson County processing plant, with all NGLs routed to Mont Belvieu for fractionation and storage.

Enterprise Products Partners operates the largest and most extensive gas gathering and processing operation in South Texas, with seven existing plants and the ability to process up to 1.5 Bcf/d. To facilitate providing additional services

Facilities	Operator	Origin/Anchor shipper	Terminus	Capacity (MMcf/d)
<b>Existing South Texas gas-processing facilities</b>	ETP/Houston Pipeline	Webb/Duval counties, Texas	ExxonMobil King Ranch Plant	< 200
<b>50-mile 24-in. Dos Hermanos lateral (2010)</b>	ETP	Webb County, Texas	Houston Pipeline	350
<b>83-mile 20-in. Chisholm lateral (2011)</b>	ETP	Dewitt County, Texas	ETP gas processing plant, LaGrange, Texas	300
<b>160-mile Rich Eagle Ford Mainline (early 2011)</b>	ETP	Dimmit County, Texas/Rosetta Resources, SM Energy, Anadarko	Connection with Chisholm pipeline Dewitt County, Texas	400
<b>70-mile REM expansion (2013)</b>		Dewitt County, Texas	Jackson County, Texas	600
<b>Gas processing plant, Jackson County, Texas</b>	ETP	REM pipeline system	Jackson County, Texas	600
<b>130-mile 20-in. NGL pipeline</b>	ETP	Jackson County plant	Mont Belvieu – Lone Star NGL LLC's fractionators and storage facilities	340,000 b/d
<b>Existing NGL storage facilities</b>	Lone Star NGL LLC	Jackson County plant	Mont Belvieu, Texas	43 million bbl
<b>Additional NGL storage facilities</b>		(new) West Texas pipeline		(Not available)
<b>New fractionator</b>	Lone Star NGL LLC	Y-grade from both Permian and Eagle Ford plants	Mont Belvieu, Texas	100,000 b/d

Table 5. Energy Transfer Partners' (ETP) Integrated Gas Gathering, Gas Processing, and NGL Transportation Facilities

for Eagle Ford producers, Enterprise proposed a number of projects that would enhance its existing capabilities as well as provide for future services. These projects included the expansion of its gathering capabilities in several individual play development areas (2011); extension of its mainline 30 miles west to reach deeper into the Eagle Ford rich gas play (2011); implementation of the White Kitchen Pipeline, a 46.5-mile gathering lateral from White Kitchen to Catarina (late 2011); 86 miles of



gas pipeline connecting Enterprise's existing Shoup Plant to its Schilling Plant (late 2011); and expansion of its mainline from White Kitchen (late 2011) to a proposed 600 MMcf/d Eagle Ford processing plant at Yoakum (early 2012).

Other projects include implementation of NGL and residue gas handling capabilities at the new Yoakum Plant, including 116 miles of pipeline to provide y-grade storage at existing Enterprise storage facilities at Seminole and a 70-mile residue (dry) gas pipeline to Enterprise's Wilson gas storage and to provide for overall gas market access via the Enterprise Texas pipeline system (late 2011). Finally, to support these upstream enhancements, two new 75,000 b/d fractionators would be added at Mont Belvieu, the first scheduled for service in 2012 and the second in 2013. As upstream volumes ramp-up over time, Enterprise will implement compression along its mainline to facilitate throughput. Table 5 provides detail on the various EPP projects.

Regency Energy Partners is expanding its gas and condensate gathering capabilities in the Eagle Ford area. As a part of the project, Regency has purchased other area midstream assets which will be integrated with its existing system. The so-called EF expansion will include a 400-mile wellhead gathering system in Webb, Dimmit, and LaSalle counties; compression; and the implementation of four gas and condensate export terminals. The condensate terminals have a capacity of 26,500 b/d. The EF expansion will occur through 2014 as required by upstream parties. Separately, Regency announced an expansion of its Tilden Treating Plant in McMullen County by 20 MMcf/d. The Tilden Plant treats sour gas associated with some of the Eagle Ford gas production.

Southcross Energy will provide natural gas gathering, transportation, and processing services for Swift Energy's Eagle Ford supply developments in McMullen County. Southcross will construct a 25-mile, 20-in. pipeline along with smaller gathering lines. Expected to be in service in mid-2011, the pipeline system will have a capacity of 120 MMcf/d and extend via Southcross' existing rich gas pipeline system to its processing plant near Gregory. Southcross will

enhance the operating efficiency of its Gregory plant, increasing its capacity to 135 MMcf/d. Southcross has also advised that it will further increase its ability to process Eagle Ford gas by implementing a new 200 MMcf/d gas processing plant in Refugio County; construction should be completed by mid-2012.

### Gas gathering/residue gas delivery

The capacity of El Paso Midstream's (EPM) Camino Real Gas Gathering System in LaSalle County is 150 MMcf/d. The system is scheduled to be in service by summer 2011 and will gather rich gas volumes for El Paso production as well as third parties. Deliveries will be into other rich gas systems in the immediate area, and processing arrangements will be made on the downstream pipelines/plant.

Meritage Midstream Services is building 25 miles of gathering pipeline in Webb County and will provide treating service to Swift Energy and others. The new pipeline will connect to Meritage's existing South Callahan treating facility – which Meritage will expand – and to its existing Escondido gas gathering system. Separately, Meritage has also entered into an agreement with Laredo Energy to build a 48-mile, 16-in. pipeline to provide market access for Eagle Ford producers.

NET Holdings Management LLC recently announced that it would provide dry gas transportation for Murphy Exploration & Production. Eagle Ford Midstream LP will build a 110-mile gas pipeline to the vicinity of Tilden, where it will connect to NET's existing LaSalle Pipeline as well as to Transco Pipeline's McMullen lateral. LaSalle Pipeline provides the full fuel-gas requirements for a 200 MW electric generation facility. A planned second phase of the project would provide for deliveries at the Agua Dulce Hub near Corpus Christi.

Numerous existing interstate and intrastate gas pipeline companies in South Texas will be providing transportation of dry gas volumes from the Eagle Ford areas to the extent their facilities are proximate to development. As many of the existing gas processing plants already connect to many of these pipeline systems, residue gas from those plants will continue to flow into these facilities.

Facilities	Operator	Origin/Anchor shipper	Terminus	Capacity (MMcf/d)
<b>Existing gas-processing plants</b> <b>Armstrong, San Martin, Schilling, Shoup, Thompsonville</b>	EPP	various	various	1,500
<b>67 miles 24-in.</b> <b>19 miles 20-in.</b>	EPP	Schilling Processing Plant	Shoup Processing Plant	>400
<b>77 miles 30-in. mainline expansion</b> <b>65 miles 36-in. mainline expansion</b>		White Kitchen, Texas	Yoakum, Texas	>1,000
<b>46 mile 24-in. lateral (north)</b>	EPP	White Kitchen/EPP mainline	Schilling Plant/EPP mainline	>500
<b>34 mile 24-in. mainline extension west (Petty)</b>	EPP	White Kitchen/EPP mainline	Catarina, Texas	>500
<b>58 miles 16-in. gathering</b> <b>10.5 miles 36-in. mainline extension</b> <b>(mid-2011)</b>	EPP	Marshall & Milford areas – EPP mainline	Yoakum Plant	>200 >800
<b>Yoakum gas-processing plant and CO<sub>2</sub> treatment plants</b> <b>(mid-2012)</b>	EPP	EPP mainline from south	Yoakum, TEXAS	600 (gas) 60,000 b/d (liquids)
<b>116-mile 16-in. NGL y-grade pipeline and 20-miles of additional connecting laterals</b> <b>(early 2012)</b>	EPP	Yoakum Plant	Seminole and Wilson storage facilities and existing EPP 16-in. ethane line for additional capacity to Mont Belvieu	60,000 b/d
<b>New liquids storage facility</b>	EPP	Yoakum Plant	Wilson storage	not available
<b>Fractionator #4 (2011)</b> <b>Fractionator #5 (2012)</b>	EPP	Yoakum Plant	Mont Belvieu, Texas	75,000 b/d 75,000 b/d
<b>69 miles 36-in. Eagle Ford residue gas pipeline (early 2012)</b>	EPP	Yoakum Plant	Wilson dry gas storage and access to EPP Texas system	1,250
<b>Dry gas storage expansion (mid-2011)</b>	EPP	Yoakum Plant	Wilson storage	~5 Bcf

Table 6. Enterprise Products Partners' (EPP) Integrated Gas Gathering, Gas Processing, and NGL Transportation Facilities

The Kinder Morgan intrastate pipelines – KM Texas and KM Tejas – have converted a significant portion of their existing South Texas-area facilities from traditional dry gas service to rich gas service. Thus, dry gas deliveries into these pipes in locations upstream of their downstream processing plant arrangements will probably be minimized. However, Kinder Morgan advises that its ability to continue to provide delivery service to downstream markets will remain strong as it will continue to receive dry gas volumes and volumes from its Markham storage facilities via facilities which remain in dry gas service.

Similarly, Trunkline Gas' South Texas interstate pipeline facilities upstream of Edna will also be converted to rich gas service. Thus, dry gas deliveries into these pipes in locations upstream of their

downstream processing plant arrangements will probably be minimized. With DCP Midstream contracting for the converted Trunkline capacity and operating its plants and its facilities on an integrated basis for rich gas service, DCP plants, post-processing, should continue to make deliveries into other South Texas-area connecting pipelines.

As one can see from the many infrastructure actions, the South Texas liquids transportation and natural gas transportation grids have been transformed significantly by the Eagle Ford development efforts. Billions of dollars have been committed to new projects, and many existing facilities will also see continuous use. Midstream infrastructure players have announced a wide variety of solutions, ensuring that Eagle Ford Shale development can reach its maximum potential. ■

A steady stream of service vehicles plies the dusty caliche roads near Tilden in McMullen County, Texas.  
*(Photo by Lowell Georgia)*







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**HART**ENERGY

# Eagle Ford Shale: South Texas Heats Up

With its three distinct windows, the Eagle Ford offers unique opportunities.

**By Mike Warren**

Executive Director, Research, Hart Energy

As a benchmark, the BHP Billiton-Petrohawk Energy Corp. deal was a validation of the global competitiveness of US shale plays and an affirmation that the Eagle Ford is emerging as the hottest play in North America this year. Although Eagle Ford acreage accounts for slightly more than one-third of Petrohawk's 1 million net acres sold to BPH Billiton, two-thirds of the South Texas acreage is located in the condensate and oil windows. In BHP Billiton's acreage positions in the Haynesville and Fayetteville, on the other hand, the acreage positions acquired from Chesapeake and Petrohawk produce nearly 100% dry gas. The Eagle Ford, with its three distinct windows,

offers unique opportunities for bigger players – both domestic and foreign – to scoop up acreage and enables tech-savvy, mid-cap E&P US companies to lift oil, gas, NGLs, and condensate.

The US \$15.1 billion deal that brought the Aussie mining giant into South Texas should help rejuvenate the lackluster deal flow exhibited in the first half of 2011. Deal flow in the domestic oil and gas industry seemed to have hit a soft patch – similar to the US economy – with only \$11.7 billion coming through in the second quarter of 2011 compared to \$27 billion in the second quarter of 2010, according to Hart Energy's Acquisitions & Divestitures Center.

Lewis Energy's  
Rig #4 drilling the  
Eagle Ford Shale in  
Webb County, Texas.  
(Photo courtesy of  
Paul Bowen)



### The Eagle Ford Play

Case Name	30-day IP (boe/d)	30-year EUR (Mboe)	G (%)	Net acreage (acres)	Well spacing (acres/well)	CAPEX (\$mm)	Type well NPV (\$mm)	Breakeven oil price (\$/boe)	Breakeven gas price (\$/mcfe)
Petrohawk (Hawkville gas-condensate)	1494	927	25.0	112000	80	8.5	6.6	28.0	3.5
Petrohawk (Black Hawk)	1738	760	25.0	73600	80	8.5	11.2	32.0	2.8
Petrohawk (Red Hawk)	328	150	5.0	50000	60	5.3	1.2	50.0	4.7
El Paso (Liquid-rich window)	614	500	30.0	105000	160	7.0	6.3	38.1	3.0
EOG Resources (Dry gas)	1193	883	98.0	49000	60	8.0	2.1	-	4.8
EOG Resources (Oil, eastern province)	1130	548	13.0	234000	125	6.5	9.4	29.7	2.5
EOG Resources (Oil, western province)	851	317	8.0	286000	140	5.5	6.3	37.5	2.7
Murphy Oil (Oil window)	580	385	17.0	65000	120	7.0	4.6	47.3	3.4
Plains E&P	800	484	15.0	60000	120	7.5	6.1	39.5	3.2
Talisman/Statoil (Joint venture)	1022	667	55.0	149000	90	7.0	4.7	48.0	3.7
ConocoPhillips (Condensate-rich area)	730	457	35.0	100000	80	8.5	3.5	49.0	4.1
ConocoPhillips (Oil rich area)	1179	518	10.0	120000	80	8.5	9.3	36.1	2.8
Newfield Exploration (Oil window)	520	378	25.0	335000	160	6.0	3.6	42.5	3.6
Anadarko/KNOC (Joint venture)	457	467	27.0	300000	160	5.5	4.4	27.7	3.3

The expected net present value is calculated at a 7.5% real discount rate (at constant prices) of a single type-well at "standard economic conditions." Crude oil, condensate, natural gas liquids, and natural gas price assumptions: \$90/bbl (oil), \$7/Mcfe (NGL) and \$6/Mcfe (gas). Operating expenses are set to \$1.5/Mcfe. Royalty and tax rates are set to 20% and 35%, respectively. Units are in millions of dollars. (Source: *North American Shale Quarterly*)

Year-to-date deal flow has similarly been soft: Only \$24.4 billion worth of announced transactions were consummated in the first half of 2011, compared to \$37 billion in the first half of 2010.

The second bellwether deal of the first half of 2011 was the Marathon acquisition of Hilcorp Resources Holdings LP, announced June 15, for \$3.6 billion in cash. Marathon acquired 141,000 net acres in four South Texas counties in all three hydrocarbon windows. According to Jack Aydin of KeyBanc Capital Markets, Marathon paid on the high end at approximately \$21,000 per acre.

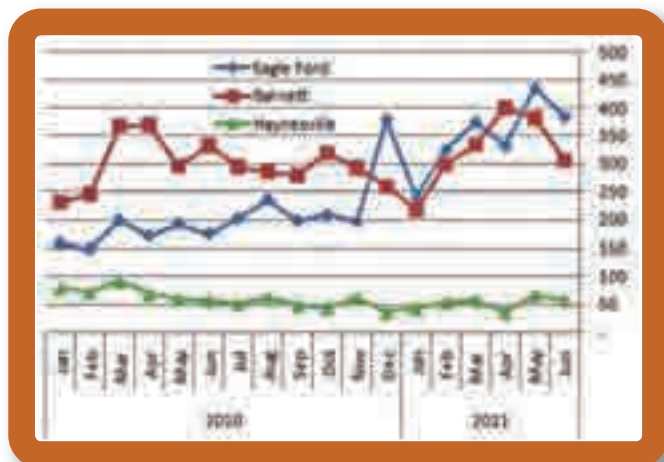
While Marathon and BHP Billiton were scooping up acreage, SM Energy concluded two deals whereby the company jettisoned roughly 100,000 acres for almost \$1 million to help finance developments in the Eagle Ford. According to SM Energy's President and CEO Tony Best, the funds "will allow us to further develop our Eagle Ford assets while locking in some solid returns and maintaining a strong balance sheet." The two deals also brought in foreign

companies – Mitsui, Statoil, and Talisman Energy – that are looking to learn more about North American plays.

Eagle Ford players also are bankrolling drilling and completions by forming joint ventures. Anadarko Petroleum Corp. took this route when it signed a \$1.55 million deal with Korea National Oil Corp (KNOC) to allow the foreign oil company to earn roughly one-third of Anadarko's interest in its South Texas basins. Suddenly, it appears the Eagle Ford is becoming the darling of international energy companies, eclipsing the Marcellus Shale play.

Acquisition prices for acreage in the Eagle Ford have risen dramatically this year. According to Aydin, deal values prior to the Mitsui deal with SM Energy averaged roughly \$12,000 to \$13,000 per acre. The Mitsui deal pushed the price up to \$17,000 to \$18,000 per acre. The Marathon deal again raised the marker to roughly \$23,000 to \$25,000 per acre. Acreage had been selling at \$4,000 to \$5,000 per acre since first quarter 2010.

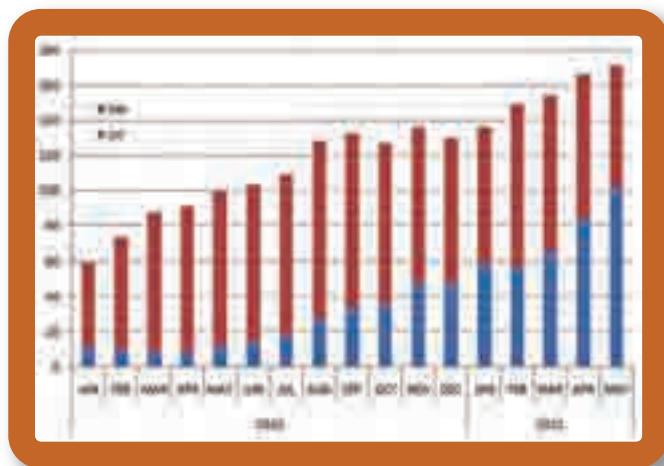




Number of new permits per month in districts 1, 2, and 4 (Eagle Ford); 7B and 9 (Barnett); and 6 (Haynesville) in the three Texas shale plays. (Data courtesy of the Texas Railroad Commission)



Rig count activity in the three Texas shale plays.



Oil and gas rig count in the Eagle Ford Shale play. (Data from the North American Shale Quarterly)

## Permitting and drilling

Permitting activity also has surged in the districts that comprise most of the Eagle Ford Shale play. New permits in districts 1, 2, and 4 have overtaken districts 7B and 9, which represent the Barnett Shale play. Some of the new field permits might also be in the Permian Basin (north-east corner of district 7B). The Haynesville has seen permit activity stay relatively constant for the past 18 months.

As permits increase, rig counts usually soon follow. The Eagle Ford rig count has surged past rig count activity in Texas's two other big shale plays – the Barnett and Haynesville. Since August 2010, the Eagle Ford has had a higher rig count than the Barnett and Haynesville combined. With rig count peaking in April 2010 and June 2010 in the Barnett and Haynesville, respectively, the gap between the Eagle Ford and the two other plays will continue to grow. By early next year, more than 200 rigs will be working the Eagle Ford.

## Production on the rise

Production is also picking up in the Eagle Ford as more resources are dedicated to lifting volumes. Most of the resources are deployed in the oil and condensate part of the play. The number of rigs dedicated to oil production eclipsed that of rigs dedicated to gas production in April 2011.

The North American Shale Quarterly (NASQ), which is a joint venture between Hart Energy and Rystad Energy, forecasts Eagle Ford production of oil, gas, NGLs, and condensate, in barrels of oil equivalent, to surpass that of the Bakken by 2012. Although oil production from the Eagle Ford Shale will not surpass that from the Bakken Shale in the NASQ forecast period (to 2020), total liquids production – excluding dry natural gas – will eclipse that from the Bakken by 2013. Moreover, the total liquids production from the Eagle Ford will remain above that of the Bakken throughout the forecast period. The Eagle Ford has more gas volume than the Bakken.

Play economics is the key driver of Eagle Ford investment from already existing players and new entrants looking to establish a toehold in South Texas. According to Rehan Rashid and Saurabh Lele of FBR



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## DUG EAGLE FORD PRESENTS THE INDUSTRY LEADERS!

Hart Energy has always been at the forefront of bringing the pertinent information directly to the operators in the Eagle Ford. The speakers at DUG Eagle Ford, and the companies they represent, hold in excess of 1.7 million net acres across the play and operate at least 50 rigs. These speakers help shape the industry.

### Preliminary Conference Program

#### MONDAY, OCTOBER 10, 2011

- 8:00 AM REGISTRATION OPENS
- 10:00 AM DRILLING WORKSHOP BEGINS
- 12:00 PM MIDSTREAM WORKSHOP BEGINS
- 5:00 PM OPENING RECEPTION ON EXHIBIT FLOOR

#### TUESDAY, OCTOBER 11, 2011

- 7:30 AM REGISTRATION OPENS - NETWORKING  
BREAKFAST ON EXHIBIT FLOOR
- 8:30 AM WELCOMING REMARKS  
*Leslie Holmes, Editor-in-Chief, Oil and Gas Investor, Hart Energy*
- 8:40 AM OPENING KEYNOTE  
*Bruce Vincent, President, Swift Energy Company  
and Chairman, IPAA*
- 9:05 AM EAGLE FORD ROCK TALK:  
GEOLOGY AND GEOPHYSICS PANEL  
*Bruce Matosky, Vice President of Exploration  
and Development, Momentum Oil & Gas LLC*  
*Peter Duncan, President, Meritium*  
*Galen Treadgold, Vice President, Senior Analyst,  
New Business, Global Geophysical*  
*Dr. Norman Wazpinski, Director of Technology,  
Pinnacle - A Halliburton Service*
- 10:15 AM NETWORKING BREAK
- 10:45 AM OPERATOR SPOTLIGHT: THE OIL WINDOW  
*Tim Dove, President and COO,  
Pioneer Natural Resources Company*
- 11:05 AM FROM ACREAGE TO DRILL BITS:  
ANALYZING THE ACTIVITY  
MODERATOR: Richard Mann, Chief Technical Director,  
Upstream, Hart Energy  
*Michael A. Hall, VP and Senior E&P Analyst,  
Wells Fargo Securities*  
*Glenn Hart, Chairman, Founder and CEO, Laredo Energy*
- 11:45 AM NETWORKING LUNCH  
Featuring Key Note Speaker  
*Dr. Robert M. Gates - 22nd US Secretary of Defense*
- 1:00 PM AFTERNOON KEYNOTE  
*Richard Stoenburner, COO, Petrolaw Energy Corporation*
- 1:30 PM TAKING THE EAGLE FORD TO MARKET:  
MIDSTREAM PANEL  
*Steve Jacobs, President, Harvest Pipeline*  
*Jim Holothik, COO, Regency Energy Partners LP*

#### On-Road Transportation Take-Away

*Greg Haas, Editor, Refinery Tracker, Hart Energy*

- 2:15 PM NETWORKING BREAK
- 2:45 PM OPERATOR SPOTLIGHT  
*John D. Clayton, Senior Vice President, Asset Development,  
Basco Resources*
- 3:10 PM OPERATOR SPOTLIGHT: EAGLE FORD IN  
LOUISIANA  
*Keith E. Jordan, President, Bulger Minerals LLC*
- 3:30 PM BUYING IN: A&D METRICS AND TRENDS  
PANEL  
*Bob Thomas, Partner, Porter Hodge LLP*  
*William A. Marko, Managing Director, Riffles & Company, Inc.*
- 4:30 PM CLOSING KEYNOTE
- 5:00 PM NETWORKING RECEPTION

#### WEDNESDAY, OCTOBER 12, 2011

- 7:30 AM REGISTRATION OPENS - BREAKFAST  
ON EXHIBIT FLOOR
- 8:30 AM WELCOMING REMARKS  
*Leslie Holmes, Editor-in-Chief, Oil and Gas Investor, Hart Energy*
- 8:35 AM OPENING KEYNOTE  
*What Shale Means to the U.S. and How the Lone Star State Leads*  
*Elizabeth Ames Jones, Chair, Texas Railroad Commission*
- 9:00 AM OPERATOR SPOTLIGHT: SOUTH TEXAS,  
A NEW LOOK  
*William E. Deupree, President and CEO,  
Everdell Resources LLC*
- 9:20 AM OPERATOR SPOTLIGHT  
*Gary D. Packer, Executive VP and COO, Newfield Exploration*
- 9:40 AM NETWORKING BRUNCH
- 10:10 AM SPOTLIGHT ON TECHNOLOGY:  
THE OPERATOR'S PERSPECTIVE  
*Mark Sundland, Drilling Manager, Anadarko Petroleum*  
*Erik Bartish, Exploration and Appraisal Asset Manager,  
Gulf Coast and Conterminous, Shell Exploration and Production  
Company*  
*Kevin O'Donnell, VP Drilling, Statoil*  
*Kevin Schepel, Vice President of Exploration & Production,  
ZuZu Energy LLC*
- 11:10 AM CLOSING KEYNOTE  
*David E. Roberts, Jr., EVP and COO, Momentum Oil Corporation*
- 12:00 PM CONFERENCE CONCLUDES

*[Agenda, timeline and program subject to change]*

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Dr. Robert M. Gates, former Secretary of Defense (2006-2011), is the only Secretary of Defense in U.S. history asked to remain in office by a newly-elected President. President Barack Obama is the eighth president Dr. Gates has served. On his last day in office, Dr. Gates was awarded the Presidential Medal of Freedom, America's highest civilian honor.

*Make plans to attend this luncheon on Tuesday, October 11*

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**Richard Stoneburner,**  
COO, *Petrohawk Energy  
Corp.*



**David E. Roberts, Jr.,**  
EVP and COO,  
*Matruh Oil Corporation*



**Gary D. Packer,** Executive  
Vice President and CEO,  
*Newfield Exploration Co.*



**Elizabeth Ames Jones,**  
Chair, *Texas Railroad  
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**John D. Clayton,**  
Sr. Vice President,  
Asset Development,  
*Rosette Resources Inc.*

## Two Great Workshops on October 10!

### DRILLING WORKSHOP

**10:00 AM – 5:00 PM**

The Drilling Workshop focuses on challenges specific to Eagle Ford development. From rig design and pad drilling to the possible benefits of automated drilling, experts provide in-depth answers to questions about drilling an Eagle Ford well.

### MIDSTREAM WORKSHOP

**12:00 AM – 5:00 PM**

The Midstream Workshop addresses key infrastructure issues in the play, from gathering systems to pipelines to processing plants. The workshop includes panels of top midstream executives discussing transportation of NGUs and oil from the play as well as M&A and MLP activity in the region.

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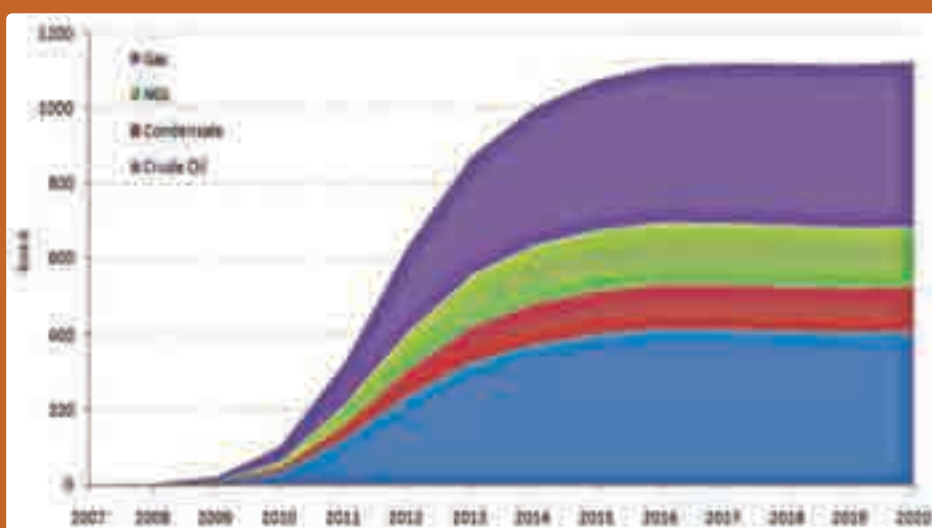


Capital Markets, “The Eagle Ford Shale asset base could ultimately be worth somewhere between \$85 billion (base case) and \$200 billion (upside case) to the industry.”

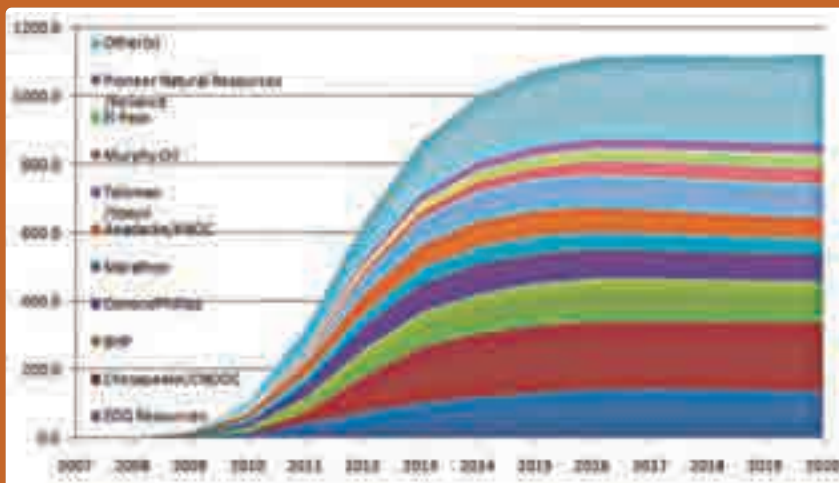
The FBR Capital Markets base case reflects the current initial production rate, estimated ultimate recovery assuming a 30-year life span, rig count activity levels, and product margins. Its upside analysis indicates that as cumulative wells drilled in other shale plays double, yields increase by 15% to 23%; the improvement in productivity is measured by increased average 30-day production rates. Of the four shale plays surveyed by FBR Capital Markets, the Fayetteville increased initial production the most at 23%, followed by the Barnett at 17.5%, the Bakken at 16%, and the Haynesville at 15%. NASQ’s base case liquids supply forecast is roughly 15% higher than the FBR Capitals base case and 25% higher when isolating just crude oil.

### Top producers

The NASQ production analysis is built from the bottom up by going to each of the major companies in the play and forecasting its production by hydrocarbon volumes. The top companies that have staked out acreage in the Eagle Ford change quite frequently from quarter to quarter as M&A activity has heated up. At press time, the joint venture between Chesapeake and the Chinese National Offshore Oil Corp. (CNOOC) held a slight edge over EOG Resources. Although BHP Billiton beat out Newfield Exploration for third place, the company’s dry gas acreage is larger than any other major player in the Eagle Ford. The Anadarko/KNOC joint venture comes in fifth.



Production by hydrocarbon type from the Eagle Ford Shale play, barrels of oil equivalent per day. (Data from the North American Shale Quarterly)



Production by company from the Eagle Ford Shale play, barrels of oil equivalent per day. (Data from the North American Shale Quarterly)

Six companies hold acreage positions between 200,000 and 250,000 net acres.

Looking at acreage positions from June 2010, the key differences are the purchase of Petrohawk by BHP Billiton and the cashing out of SM Energy. Shell and Pioneer Natural Resources have actually built their acreage position compared to one year ago.

Given the rapidly rising rig counts, the production rates of individual companies should see a rather rapid ramp upward. While EOG Resources has the



## Introducing the Eagle Ford Task Force

Created to assure proper development of what may be Texas's most significant economic development ever — the Eagle Ford covers 24 counties — Texas Railroad Commissioner David Porter recently announced members of the Eagle Ford Task Force. The group's task is three-fold: to facilitate communication among the play's many parties and stakeholders, to establish best practices for development, and to promote economic benefits both locally and statewide.

Its members include local community leaders, elected officials, water representatives, environmental groups, oil and gas producers, pipeline companies, oil services companies (including a hydraulic fracturing company, a trucking company, and a water resources management company), landowners, mineral owners, and royalty owners.

Members of the task force are:

*Leodoro Martinez* - Middle Rio Grande Development Council, Executive Director, of Cotulla

*Erasmo Yarrito* - Texas Commission on Environmental Quality, Rio Grande Valley Water Master, of Harlingen

*Kirk Spilman* - Marathon Oil, Asset Manager Eagle Ford, of San Antonio

*Steve Ellis* - EOG Resources, Senior Division Counsel, of Corpus Christi

The Honorable *Jaime Canales* - Webb County Commissioner, Precinct 4, of Laredo

The Honorable *Daryl Fowler* - Dewitt County Judge, of Cuero

*Teresa Carrillo* - Sierra Club, Executive Committee Member - Lone Star Chapter, Treasurer - Coastal Bend Sierra, of Corpus Christi

*Brian Frederick* - DCP Midstream, Southern Unit Vice President for the East Division, of Houston

*Anna Galo* - Vice President, ANB Cattle Company, of Laredo

*James E. Craddock* - Rosetta Resources, Senior Vice President, Drilling and Production Operations, of Houston

The Honorable *Jim Huff* - Live Oak County Judge, of George West

lead in production as of July 2011, by year-end 2012 the Chesapeake/CNOOC joint venture will likely produce more barrels of oil equivalent given the current acreage positions and production schedule announcements. For the time being, BHP Billiton's production forecast is an extension of what Petrohawk had planned. Recent statements suggest, however, that BHP will spend more on drilling and completion costs going forward in all the acreage acquired from Petrohawk. The NASQ forecasts suggest that the Talisman/Statoil joint venture, which didn't make the top 10 in acreage positions, will likely become the fourth-largest volumetric producer in the Eagle Ford given deep pockets and an aggressive drilling schedule. The Anadarko/KNOC joint venture, Marathon Oil, and Murphy Oil are each expected to produce approximately 50,000 boe/d by the end of the forecast period. The top 10 is rounded

out by Pioneer Natural Resources and El Paso, which didn't make the list in acreage positions. Newfield Exploration and Shell, despite being in the top 10 in acreage, did not make the top 10 in production.

The Eagle Ford has several small- to mid-cap producers that will contribute significant volumes from the play. Cabot Oil & Gas and Magnum Hunter have working relationships with EOG Resources. Lucas Energy, Goodrich Petroleum Corp., Rosetta Resources, and Swift Energy all have acreage positions augmented by company permits, and rig activity should raise production from the Eagle Ford. Hence, the "other" producers already out-produce the individual heavyweights. The NASQ expects this trend to continue throughout the forecast period. Finally, ExxonMobil and British Petroleum also have sizable acreage positions and deep pockets to add to volumes to the Eagle Ford.

The NASQ believes that the Eagle Ford Shale play will produce more liquids volumes than any other play in North America. The rationale behind this assessment is that the economics suggest companies will view their Eagle Ford acreage positions with higher internal rates of return and high net present valuations:

- Geology is favorable and comparable to the Bakken Shale play;
- The Eagle Ford will benefit from advances in completion technologies at an earlier stage of its development than the Bakken;
- Play acreage and well spacing are optimized in sparsely populated and easily accessible locations;
- The play should be developed year-round with better climatic conditions;
- Initial production rates have been improving materially as the Eagle Ford is a more recently developed play with lessons learned from the Bakken Shale play; and
- The play is closer to consuming and oil-processing regions with the ability to export production.

Looking at some of the players in the Eagle Ford and the Bakken, the NASQ estimates the weighted, breakeven price for a barrel of oil equivalent will average roughly \$5 per barrel cheaper in the Eagle Ford in the forecast period.

### Most valuable players

Looking specifically at individual companies, the positions held by Chesapeake, BHP Billiton, and EOG Resources appear to be the most valuable in the play when measuring net present valuation, estimated ultimate recovery, and break-even prices. In fact, while BHP Billiton may have been criticized in the financial press for paying too much for its acquisition of Petrohawk, NASQ's analysis suggests that, at least for the Eagle Ford, its positions were highly rated. ConocoPhillips also appears to hold solid positions. Anadarko and Plains E&P hold middle-level tier positions when looking at our matrix. Solid positions are also held by Murphy Oil and Newfield Exploration. ■

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# Additional Information on the Eagle Ford Shale, 2009 to Present

For more details on the Eagle Ford Shale, consult the selected sources below.

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By **Ann Priestman**, Editor, Unconventional Gas Center

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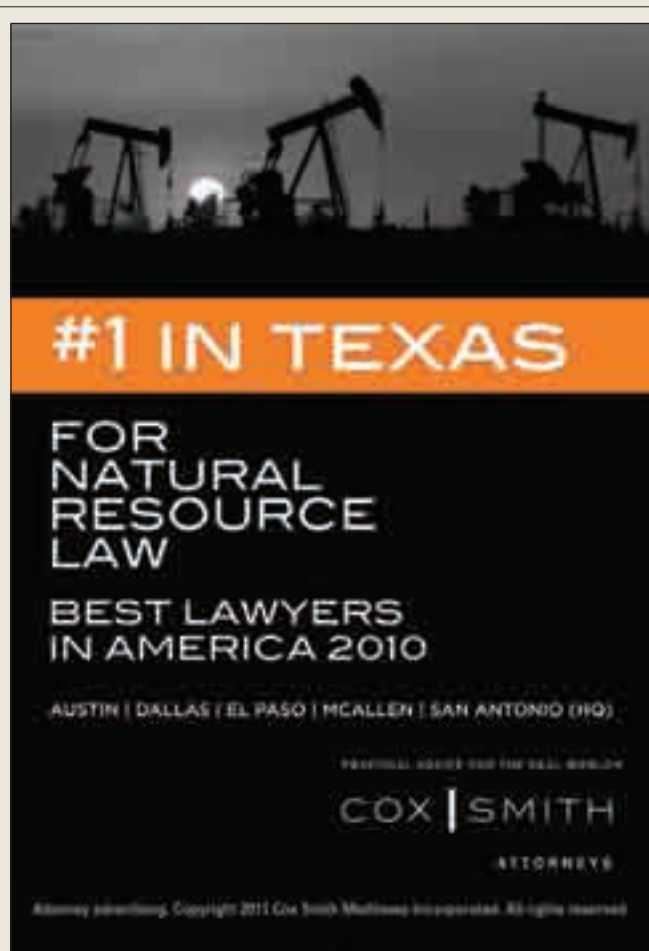
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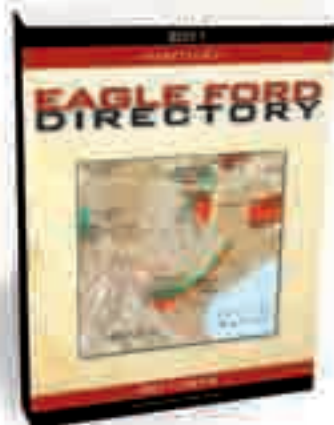
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