Evolution and Development of the WolfBone Play, Southern Delaware Basin, West Texas: An Emerging Frontier, An Oil-Rich Unconventional Resource*

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Abstract

The WolfBone play is an emerging unconventional oil-resource in the southern Delaware Basin. Exploration and development has been a systematic, progressive evolution from geologic concept to drilling, production, evaluation and revision of targets. Originally exploration focused on Wolfcamp sandstone reservoirs below and Third Bone Springs sandstone reservoirs above to current focus on the 1000-ft-thick, oil-rich, unconventional Wolfcamp shale.

The Wolfcamp is an ideal heterogenetic resource consisting of quartz, carbonate and kerogen. Exploration and field development will be successful over a large area. However, the geologic and economic sweet spot is limited to the proximal basin floor on the gently dipping western flank. In this setting quartz and kerogen accumulated in the quiet deep basin interrupted by episodic deposition of shelf to basin-floor carbonate debris flows that settled at the de-acceleration boundary between the slope and basin floor. These depositional processes resulted in compositional and grain-size heterogeneities and accumulation of the thick organic-rich, technically and economically exploitable targets.

During maturation large volumes of oil were sealed in-place (108 MMBOIP per section). Expansion from kerogen to oil in a sealed system resulted in overpressure. Individual wells have flowed 45 MBO from 11,000 ft prior to initiating artificial lift; atypical of Permian Basin reservoirs. Farther into the basin and upslope these conditions do not exist and are outside the economic sweet spot. Basinward the unit is consistently thick; however, there is more shale, and it is starved of siltstones and carbonates. Upslope the unit thins and is gas-prone; the mixture of coarser-grained shelf carbonates and sandstones provided migration pathways breaching the closed system, limiting productivity and ultimate economic recoveries.
Since 2009, this play has been developed with vertical wells comingling the oil-resource with conventional reservoirs. Interpretation of imaging logs has identified the primary fracture orientation and zones with conjugate fractures systems. Integration with production logs has optimized horizontal target identification, and horizontal drilling has begun. The Avalon, being exploited in New Mexico, is also present. The Avalon sweet spots occur at similar depositional setting as the Wolfcampian resource and the same geographic position in this portion of the basin. The Avalon is estimated to have 103 MMBOIP per section.

References


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Most active US basin with 433 rigs (Delaware Basin: 214), Hz Rigs: ~35\%(1)

Total Resource in place per section: 108 Mmboe
- **Horizontal Development:**
  - Alternative Wolfcamp development strategy modeled
  - 3rd Bone Spring development

**Upside Potential**
- Horizontal resource in Avalon Shale
  - Avalon Shale - 105 MMboe in place per section
- Delaware Sands - ongoing vertical & horizontal exploitation
- Vertical drilling targeting deeper gas zones

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(1) Source: RigData, TPH. Hz % includes horizontal and directional rigs. As of September 30, 2011 or most recent data available.
The Permian is the Premier US Oil Basin

Multi-Zone Vertical and Hz Development Potential

- **Wolfbone**
  - Commingled vertical wells that capture oil-rich 3rd Bone Spring and Wolfcamp over a 1,250' interval
  - Overpressured analog to Wolfberry in the Midland Basin
  - High-liquid content provides superior economics
  - 108 MMboe in-place per square mile

- **Wolfcamp**
  - Horizontal drilling has begun in TX and Eddy, NM
  - Thick interval provides multi-lateral potential

- **3rd Bone Spring**
  - Substantial nearby horizontal drilling

- **Avalon Shale**
  - Up to 1,000’ gross thickness across the basin
  - Laterally extensive & continuous across Reeves, Co.
  - 105 MMboe in-place per square mile

- **Delaware Sands (Brushy, Cherry, and Bell Canyon)**
  - Vertical & horizontal exploitation of the 3,000 - 3,500’ thick interval with dozens of potential pays

Eagle Development is Proving Many Zones

- Eagle currently produces 1,888 boe/d from 28 wells
  - 24 vertical wells commingling production across 3rd Bone Spring members and Upper Wolfcamp members
  - 4 horizontal wells drilled into the 3rd Bone Spring Sands

- Eagle is currently drilling their first horizontal Wolfcamp well in the Upper Wolfcamp Shale B member
  - Excellent results to date with >100’ flares during drilling with 12.6 ppg mud
  - Over 100 bbl oil returned to pit while drilling lateral
Production from the Permian System

Summary

- Permian system comprised of multiple basins:
  - Delaware Basin
  - Central Basin Platform
  - Midland Basin
- Development progression:
  - Early production from shallow formations on the basin edges
  - Transition to deeper deposits in the central Delaware (Avalon, Bone Spring, & Wolfcamp)
- Recent basin revitalization:
  - Comingled vertical completions
  - Modern horizontal drilling and completion technologies

Permian Basin Structure

Permian Basin Cross Section

Delaware Basin Deposition

- 2 depositional systems in place
  - Deep submarine channels running off the NW Shelf and Central Basin Platform
  - Periods of influx of carbonate debris
- 3rd process in generation of organics in the photic zone across the entire basin as debris settled
  - Mostly organics settling in the deep basin; carbonates mainly deposited on the Shelf and on the Slope
Recent Nearby Industry Results

- **Avalon Shale**
  - Chesapeake
  - Ross Ranch Federal 6-1H
    - IP rate: 1,528 boe/d
  - Apache
    - Bullhead 55-1-41 1H
      - IP rate: 835 boe/d

- **Bone Spring**
  - Chesapeake
    - Johnson 1-86
      - 30-day rate: 920 boe/d
    - Monroe 1-17
      - 30-day rate: 1,614 boe/d
  - Devon
    - Talladega 65 1H
      - 30-day rate: 1,281

- **Wolfbone**
  - J. Cleo Thompson
    - Perry State 204
      - 30 day rate: 549 boe/d
    - Terrill State
      - 30-day rate: 313 boe/d
  - Cimarex
    - KHC '33-26'
      - 30-day rate: 1,226
  - Anadarko
    - Monroe 34-220
      - 30-day rate: 1,345 boe/d
    - Blacktip Johnson 1-39H
      - 30-day rate: 1,364 boe/d
    - Perry State 40
      - 30 day rate: 708 boe/d
  - Chevron
    - Colonel Drake 24 1H
      - 30-day rate: 518 boe/d
  - Whiting
    - KHC '33-26'
      - 30-day rate: 1,226
  - Other
    - Eagle Acreage
      - 30 day rate: 708 boe/d

Source: HPDI, Corporate IR Presentations.
The Wolfcamp shale is a highly overpressured source rock and reservoir in the Eagle area of the Delaware Basin.
Wolfcamp – The Source of the Delaware’s Success

Wolfcamp Geologic Characterization

- Ideal mineralogy and grain-size distribution to behave as both a source rock and a reservoir
- 108 MMboe in-place per square mile
- Approximately 1,000’ thick
  - 2-5% TOC
  - 50-90% quartz & carbonate, 10% clay
- 0.7 psi/ft pressure gradient
  - From in-situ hydrocarbon generation & storage
  - Higher production rates
  - Shallower declines
- Carbonate debris flows were the primary target
  - Conventional Wolfcamp production
- Industry now targeting the source rock
  - Modern D&C techniques
Wolfbone Industry Activity

J. Cleo Thompson
Perry State 40
30-day avg: 708 boe/d

J. Cleo Thompson
Chapman State
30-day avg: 223 boe/d

Concho Resources
Dutch 24
30-day avg: 204 boe/d

J. Cleo Thompson
Chevron Minerals 29
30-day avg: 203 boe/d

J. Cleo Thompson
Terrill State
30-day avg: 313 boe/d

Source: HPDI and Eagle data. Producing wells.

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Eagle Operated Wolfbone Production

Total Current Net Production: 1,780 boe/d (2,404 boe/d gross) (1)

Includes 17 operated wells

Source: Company Data
(1) Production Data as of 9/30/11.
Eagle Wolfbone Production

Total Current Net Production: 1,869 boe/d
(2,930 boe/d gross) \(^{(1)}\)
Includes 24 wells (17 operated)

Daily Production Rate (boe/d)

Source: Company Data

(1) Production Data as of 9/30/11 or most recent data available.
Wolfbone 30-Day IP Bubble Map

NOTE: Wells completed as Wolfbone producers after 1/1/2009 - Hoban, Hoban South, Wolfbone fields.

All completions >350 bbl/d are less than 12 mo. old

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Production Logs = Precision Completions

Production Logs Used to Identify Target Intervals

- Eagle has run production logs in 9 Wolfbone wells
- Tool has multiple sensors to identify contributing intervals:
  - Spinner with dual-axis caliper
  - Pressure and temperature sensors
  - Digital Entry Flowview Imaging Tool (DEFT)
    - Water measurement
  - Gas Holdup Optical Sensing Tool (GHOST)
    - Gas measurement

Relative Flow Contribution by Member

- Total Hydrocarbon (boe)
- Water

- 2nd BS Detrital (1 Well)
- 2nd BS Shale Upr (2 Wells)
- 2nd BS Shale Lwr (3 Wells)
- 3rd BS Sands (9 Wells)
- Upr Wolfcamp Shale A (9 Wells)
- Upr Wolfcamp Shale B (8 Wells)
- Mid Wolfcamp Shale A (8 Wells)
- Mid Wolfcamp Shale B (9 Wells)
- Mid Wolfcamp Sands A (8 Wells)
- Mid Wolfcamp Sands B (3 Wells)
- Mid Wolfcamp Sands C (4 Wells)
- Mid Wolfcamp Sands D (1 Well)

Previously Drilled Hz Target

Current Hz Target

Monroe 39 #2H

Water-bearing zones
No longer completed

Full logs available in VDR

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Plugging Water-Bearing Zones Improves Profits

**Pistola #1 Case History**
- Eagle’s 2nd Wolfbone completion
- Well initially flowed >1,000 bblw/d
- Leveled out ~150 bblw/d
- Re-entered wellbore and cement squeezed Middle Wolfcamp Sands C&D
- Re-completed Middle and Upper Wolfcamp shales and 3rd Bone Spring Sands
- **Well IP’d > 450 bopd following intervention**

**City of Pecos 15 #1 Case History**
- Eagle’s 6th Wolfbone completion
- Well initially flowed >1,200 bblw/d
- Decreased to ~600 bblw/d over 30 days
- Re-entered wellbore and cement squeezed Middle Wolfcamp Sands C
- Re-completed Middle and Upper Wolfcamp shales and 3rd Bone Spring Sands
- **WOR cut in half to ~1.5 from 3+ vastly improving economics**
Wolfbone Typical Vertical Well Plan (Billy the Kid 31 #1)

11,650' TD

11 Stage Frac

- Completion Type
  - Open hole w/ sliding sleeves and packers

- Stimulation (per stage)
  - 35,000 # 100 mesh sand
  - 95,000 # 20/40 sand
  - 25,000 # 20/40 resin-coated proppant
  - 160,000 gal slickwater / X-link gel

- Stimulation (total job)
  - 1.7 MM# proppant
  - 1.8 MM gals fluid

Eagle has used 2 rigs to drill each Wolfbone well:
1. Spudder rig 800 HP drills to 5,000’ and sets intermediate casing
2. 1,200 HP rig drills to TD, sets production casing

Eagle currently operates 2 larger rigs (1,200 HP and 1,500 HP)
Wolfbone Drilling Curves

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### Focusing the Effort

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<th>M28 #1</th>
<th>PB203 #1</th>
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Most recent wells completed consistently with excellent results

Continued improvements lead to targeted completions

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Geographically Different - Same Improvement

Northern Area

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<tr>
<th>Peak Rate (boe/d)</th>
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<th>Pistola #2</th>
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Southern Area

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IP’s Trending Upward as Completions Improve

-5% IP increase with every subsequent completion

Average = 148 bbl/d

North Wells

South Wells

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NOTE: Eagle operated Wolfbone completions.
Honoring Recent Data

Recent well data; supports type curve IP

- City of Pecos 16 #1
- Doc Holiday 34 #1
- Billy The Kid 31 #1
- Wyatt Earp 22 #1
- EXL Leslie 11 #1

Oil Rate (bbl/d) vs Days Online

- Last 5-Well Average
- Eagle Type Curve

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Wolfbone Oil Production History (Eagle Operated)

Average Oil Rates (bbl/d) \(^{(1)}\)

<table>
<thead>
<tr>
<th>Peak</th>
<th>SH #1</th>
<th>PIST #1</th>
<th>Bell #1</th>
<th>BR 41 #1</th>
<th>Capps #1</th>
<th>CP15 #1</th>
<th>Bell #2</th>
<th>M28 #1</th>
<th>PB203 #1</th>
<th>RR21 #1</th>
<th>M39 #1</th>
<th>Capps #2</th>
<th>Bell #3</th>
<th>CP16 #1</th>
<th>DH34 #1</th>
<th>BTK31 #1</th>
<th>WE #22</th>
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</thead>
<tbody>
<tr>
<td>7-day</td>
<td>189</td>
<td>472</td>
<td>133</td>
<td>474</td>
<td>403</td>
<td>262</td>
<td>364</td>
<td>540</td>
<td>421</td>
<td>295</td>
<td>465</td>
<td>290</td>
<td>124</td>
<td>343</td>
<td>468</td>
<td>292</td>
<td>396</td>
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<tr>
<td>30-day</td>
<td>124</td>
<td>22</td>
<td>74</td>
<td>246</td>
<td>134</td>
<td>160</td>
<td>187</td>
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<td>241</td>
<td>72</td>
<td>193</td>
<td>216</td>
<td>158</td>
<td>292</td>
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<tr>
<td>60-day</td>
<td>120</td>
<td>18</td>
<td>60</td>
<td>244</td>
<td>137</td>
<td>148</td>
<td>174</td>
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<td>156</td>
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<td>117</td>
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<tr>
<td>90-day</td>
<td>104</td>
<td>29</td>
<td>54</td>
<td>227</td>
<td>119</td>
<td>137</td>
<td>174</td>
<td>244</td>
<td>158</td>
<td>111</td>
<td>180</td>
<td>67</td>
<td>126</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>180-day</td>
<td>70</td>
<td>72</td>
<td>41</td>
<td>182</td>
<td>99</td>
<td>114</td>
<td>144</td>
<td>214</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
<td>NA</td>
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<td>NA</td>
</tr>
<tr>
<td>365-day</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
<td>NA</td>
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</tr>
</tbody>
</table>

\(^{(1)}\) Corrected for shut-ins.
Wolfbone Gas Production History (Eagle Operated)

(1) Corrected for shut-ins.

Average Gas Rates (Mcf/d)\(^{(1)}\)

<table>
<thead>
<tr>
<th>Peak</th>
<th>SH #1</th>
<th>PIST #1</th>
<th>Bell #1</th>
<th>BR 41 #1</th>
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<th>PB203 #1</th>
<th>RR21 #1</th>
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<th>Capps #2</th>
<th>Bell #3</th>
<th>CP16 #1</th>
<th>DH34 #1</th>
<th>BTK31 #1</th>
<th>WE #22</th>
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<tbody>
<tr>
<td>7-day</td>
<td>758</td>
<td>89</td>
<td>413</td>
<td>651</td>
<td>249</td>
<td>790</td>
<td>14</td>
<td>907</td>
<td>987</td>
<td>697</td>
<td>230</td>
<td>35</td>
<td>291</td>
<td>621</td>
<td>667</td>
<td>535</td>
<td>563</td>
</tr>
<tr>
<td>30-day</td>
<td>237</td>
<td>31</td>
<td>245</td>
<td>441</td>
<td>266</td>
<td>534</td>
<td>211</td>
<td>181</td>
<td>461</td>
<td>275</td>
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<td>84</td>
<td>227</td>
<td>353</td>
<td>359</td>
<td>512</td>
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<tr>
<td>60-day</td>
<td>278</td>
<td>43</td>
<td>161</td>
<td>399</td>
<td>242</td>
<td>435</td>
<td>230</td>
<td>393</td>
<td>334</td>
<td>242</td>
<td>316</td>
<td>96</td>
<td>192</td>
<td>262</td>
<td>255</td>
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<td>NA</td>
</tr>
<tr>
<td>90-day</td>
<td>262</td>
<td>54</td>
<td>129</td>
<td>364</td>
<td>208</td>
<td>380</td>
<td>247</td>
<td>427</td>
<td>291</td>
<td>210</td>
<td>280</td>
<td>90</td>
<td>158</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>180-day</td>
<td>202</td>
<td>95</td>
<td>91</td>
<td>305</td>
<td>151</td>
<td>318</td>
<td>220</td>
<td>395</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>365-day</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Gas Production Rate (Mcf/d)

© Eagle Oil & Gas, Co., 2012
BELL 213-A2 ("TYPE WELL"), RATE : CUM (BO)

\[ y = 5046.1e^{-0.05x} \]

\[ R^2 = 0.5546 \]
MONROE 28 #1 ("HIGH-SIDE WELL")
RATE: CUM (BO)

\[ y = 10000e^{-0.05x} \]
\[ R^2 = -0.807 \]
Average Wolfbone GOR

2,000 GOR used to generate gas volumes for Wolfbone type curve

<table>
<thead>
<tr>
<th>Average GOR, scf/bbl</th>
<th>Days on Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10,000</td>
<td>360</td>
</tr>
</tbody>
</table>

NOTE: Data based on Eagle operated Wolfbone completions.

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Wolfbone Fluid Analysis (Balmorhea Ranch #1)

Summary

**Oil**
- Lab: Mitchell Analytical Labs
- Date Sampled: 11/15/2010
- API: 49.0
- Gravity: 0.7839

**Gas**
- Source: Mitchell Analytical Labs
- Date Sampled: 1/11/2011
- Gravity: 0.8293
- Wellhead HV (BTU/Mcf): 1,413

---

**Gas Compositional Analysis**

<table>
<thead>
<tr>
<th>Component</th>
<th>Mole (%)</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>N2 Nitrogen</td>
<td>0.959</td>
<td></td>
</tr>
<tr>
<td>CO2 Carbon Dioxide</td>
<td>0.221</td>
<td></td>
</tr>
<tr>
<td>C1 Methane</td>
<td>70.178</td>
<td></td>
</tr>
<tr>
<td>C2 Ethane</td>
<td>13.245</td>
<td>3.533</td>
</tr>
<tr>
<td>C3 Propane</td>
<td>8.745</td>
<td>2.403</td>
</tr>
<tr>
<td>NC4 n-Butane</td>
<td>3.124</td>
<td>0.982</td>
</tr>
<tr>
<td>IC4 Isobutane</td>
<td>1.049</td>
<td>0.343</td>
</tr>
<tr>
<td>NC5 n-Pentane</td>
<td>0.802</td>
<td>0.290</td>
</tr>
<tr>
<td>IC5 Isopentane</td>
<td>0.688</td>
<td>0.251</td>
</tr>
<tr>
<td>C6+ Hexanes Plus</td>
<td>0.989</td>
<td>0.438</td>
</tr>
</tbody>
</table>

**Total**
- Mole: 100.000
- GPM: 8.240

---

**NGL Recovery**
- 173 bbl/MMcf Recovered
- Range: 163 - 236 bbl/MMcf

<table>
<thead>
<tr>
<th>Component</th>
<th>Theoretical</th>
<th>Plant Recovery (%)</th>
<th>Actual (GPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2 Ethane</td>
<td>3.5330</td>
<td>77.0%</td>
<td>2.7204</td>
</tr>
<tr>
<td>C3 Propane</td>
<td>2.4030</td>
<td>95.5%</td>
<td>2.2949</td>
</tr>
<tr>
<td>NC4 n-Butane</td>
<td>0.9820</td>
<td>97.0%</td>
<td>0.9525</td>
</tr>
<tr>
<td>IC4 Isobutane</td>
<td>0.3430</td>
<td>97.0%</td>
<td>0.3327</td>
</tr>
<tr>
<td>NC5 n-Pentane</td>
<td>0.2900</td>
<td>97.0%</td>
<td>0.2813</td>
</tr>
<tr>
<td>IC5 Isopentane</td>
<td>0.2510</td>
<td>97.0%</td>
<td>0.2435</td>
</tr>
<tr>
<td>C6+ Hexanes Plus</td>
<td>0.4380</td>
<td>97.0%</td>
<td>0.4249</td>
</tr>
</tbody>
</table>

**Total (GPM)**
- 8.2400
- 89.0%
- 7.2502

---

(1) Oil data from City of Pecos 15 #1

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Wolfbone Processing Statement

**Gross Wellhead:** 7,717 Mcf

**Net Residue:** 5,217 Mcf

**Gathering Fee:** $0.1500/Mcf

**Plant Efficiency:** 89.0%

**Residual:** 68%

**NGLs (theoretical):** 7,6482 GPM

**173 bbl/MMcf NGL Yield**
Realized Gas Pricing

Actual Historical Gas Pricing

- Eagle captures liquids benefit in realized gas stream revenue
- Average 221% realized gas price relative to NYMEX over last 5 mo’s

Theoretical Gas Pricing

- NGL extraction not captured in production / sales volumes
- Benefits of liquids content in sales gas modeled with 220% BTU multiplier (i.e., 220% differential)
- Illustrative example:

Wellhead Production: 1,000 Mcf

89% Efficiency

32% Shrinkage

NGLs: 173 bbl recovered

Sales Gas: 680 Mcf

Realized Price (1)

\[ 0.53 \times 89.48/\text{bbl} = 47.42 \]

\[ 0.892 \times 4.19/\text{Mcf} - 0.15 = 3.58 \]

Revenue:

- NGL: $8,200
- Gas: $2,400
- Total: $10,600

Realized Pricing:

\[ \frac{10,600}{4.19/\text{Mcf} \times 1,000 \text{ Mcf}} = 253\% \]

(1) NGL pricing based on WTI, gas pricing based on NYMEX June 2010 - July 2011 before differentials applied to both.

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Drilling a single vertical well allows an operator to book the following:
- 1 PDP
- 8 PUD
- 16 Probable
- 56 Possible

80 total 3P locations

Using a “fence post” development technique allows an operator to quickly prove an entire field.

Eagle has already proven a large portion of their acreage → Only 11 wells required to convert 100% of locations to 3P.
40-Acre Spacing Works in the Wolfbone

Focused Fracture - Capps 214 #1 Case Study
- Bell 213 #1 completed as a “typical” sandstone
  - Unconcentrated frac targeted sand intervals
    - Wolfcamp Upper and Middle A Shales
    - 3rd Bone Spring Sand
    - Not completed in Wolfcamp Upper B Shale
  - Wolfcamp C & D Sands produced excessive water and were plugged
- Capps 214 #1 was completed with a more focused “shale frac”
  - Upper and Middle Wolfcamp Shale
  - Wolfcamp A & B Sand
  - 3rd Bone Spring Sand
  - >2x Bell 213 #1 peak production rate

Same Area - Completely Different Results

Bell/Capps Lease (Southern Area of Eagle Position)

Bell 213 #1
- Peak rate: 202 boe/d

Capps 214 #1
- Peak rate: 445 boe/d

NOTE: Bell 213 #1 was completed in the WC Upr and Mid A shales → but not in the best zone, the WC Upr B shale
40-Acre Spacing Works in the Wolfbone

Wolfbone 40-acre Case Study (Bell Lease)
- Bell 213 1, “A” 2, and “A” 3 drilled ~6 months apart
  - 213 1: June 29, 2010
  - 213 “A” 2: Jan 13, 2011
  - 213 “A” 3: May 21, 2011
- No observed interference during completion or production
- Decline rate unaffected by offsetting production
- 40-acre spacing is norm in the Wolfberry (analog)
  - 20-acre development underway in many areas

Wolfbone Down-Spacing Potential (Recovery Factor)
- Oil-in-Place per sq mile = 108 MMboe

<table>
<thead>
<tr>
<th>Well Spacing (acres)</th>
<th>EUR/Well (Mboe)</th>
<th>200</th>
<th>225</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td></td>
<td>3.0%</td>
<td>3.3%</td>
<td>3.7%</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>5.9%</td>
<td>6.7%</td>
<td>7.4%</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>11.9%</td>
<td>13.3%</td>
<td>14.8%</td>
</tr>
</tbody>
</table>

Bell Lease (Southern Area of Eagle Position)
- Bell 213 “A” 3
  - 30-day avg: 193 bbl/d
- Bell 213 “A” 2
  - 30-day avg: 183 bbl/d
- Bell 213 1
  - 30-day avg: 69 bbl/d

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Wolfbone... the Delaware’s Wolfberry... only Better

Industry Bringing Midland Basin Technology to the Delaware

- Industry has increased Wolfberry EUR over time by comingling more zones
  - Activity significantly increased with improved results (now > 700 wells/year)
- Deeper, overpressured Delaware yielding superior Wolfbone EUR vs. Wolfberry
- Wolfbone wells flow 3-6 months before pump (20+ Mbo)

<table>
<thead>
<tr>
<th>Wolfbone (Delaware)</th>
<th>Wolfberry (Midland)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Zones</td>
<td>3rd Bone Spring to Wolfcamp</td>
</tr>
<tr>
<td></td>
<td>Upr Spraberry to Wolfcamp</td>
</tr>
<tr>
<td>Additional Zones</td>
<td>Delaware Sands, Avalon Shale, Deeper zones</td>
</tr>
<tr>
<td></td>
<td>Non-traditional shale/silt zones and Deeper Zones (Strawn, Atoka, Mississippian)</td>
</tr>
<tr>
<td>EUR (Mboe)</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>165</td>
</tr>
<tr>
<td>% Liquids</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td></td>
<td>~ 65%</td>
</tr>
<tr>
<td>Depth (feet)</td>
<td>11,000 - 12,500</td>
</tr>
<tr>
<td></td>
<td>7,500 - 11,000</td>
</tr>
<tr>
<td>Spacing (acres)</td>
<td>40 acres</td>
</tr>
<tr>
<td></td>
<td>40 acres (current), testing on 20</td>
</tr>
<tr>
<td></td>
<td>1 well will HBP 160 acres</td>
</tr>
</tbody>
</table>

© Eagle Oil & Gas, Co., 2012

(1) Chart adapted from Pioneer Natural Resources.
(2) Approximate yearly average.
Wolfberry vs. Wolfbone

Wolfbone has Superior Reservoir Properties

- **Depth and Pressure → Greater Reservoir Energy**
  - Wolfbone is highly overpressured (~ 0.7 psi/ft)
  - Wolfbone is ~ 2,000’ deeper
  - **Wolfbone up to 2x Wolfberry pressure**

- **Thicker vertical section leads to additional upside**
  - Both completed over 1,250’ interval
  - Wolfbone has 2,000’ additional potential

- **Substantial upside in the Delaware Basin**
  - Uphole potential in Delaware Sands
  - Hz development

Wolfbone Well Count is Quickly Growing
Wolfbone Type Curve (vs. Wolfberry)

- **Oil Rate (Bbl/d)**
  - Wolfbone
  - Wolfberry

- **Months Online**
  - 0
  - 24
  - 48
  - 72
  - 96
  - 120

- **GOR (scf/stb): 2,000**

<table>
<thead>
<tr>
<th></th>
<th>Wolfbone</th>
<th>Wolfberry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wellhead EUR (Mboe)</td>
<td>240</td>
<td>141</td>
</tr>
<tr>
<td>Oil EUR (Mbbl)</td>
<td>180</td>
<td>105</td>
</tr>
<tr>
<td>Gas EUR (MMcf)</td>
<td>359</td>
<td>211</td>
</tr>
<tr>
<td>% Oil</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>24-hour Oil IP (bbl/d)</td>
<td>200</td>
<td>80</td>
</tr>
<tr>
<td>24-hour Gas IP (Mcf/d)</td>
<td>400</td>
<td>160</td>
</tr>
<tr>
<td>Hyperbolic Exponent</td>
<td>0.4</td>
<td>1.5</td>
</tr>
<tr>
<td>1st Year Decline</td>
<td>43%</td>
<td>59%</td>
</tr>
<tr>
<td>Terminal Decline</td>
<td>10%</td>
<td>6%</td>
</tr>
</tbody>
</table>

(1) 2009+ vintage Wolfberry completions.

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Drilling a single horizontal well allows an operator to book the following:

- 1 PDP (4 x 40 Ac)
- 4 PUD (16 x 40 Ac)
- 8 Probable (32 x 40 Ac)
- 28 Possible (112 x 40 Ac)

40 total Hz 3P locations

Horizontal wells are being used to prove fields quickly in North Dakota using the “fence post” development plan.

2009 SEC booking guideline changes made proving reserves with horizontal wells more favorable to operators.

- Old method: Only direct lateral offsets
- New method: Includes toe+ heel offsets

Eagle is currently completing their first Wolfcamp Shale horizontal well.
*Courtesy of Carrollton Minerals Partners*

Avalon –
- ~800’ thick.
- 105 MMboe in-place per sq. mile

<table>
<thead>
<tr>
<th>Period</th>
<th>Unit</th>
<th>~ Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guadalupian</td>
<td>Bell Canyon</td>
<td>8,800</td>
</tr>
<tr>
<td></td>
<td>Cherry Canyon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brushy Canyon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper Avalon Shale</td>
<td>9,600</td>
</tr>
<tr>
<td></td>
<td>Lower Avalon Shale</td>
<td>9,850</td>
</tr>
<tr>
<td></td>
<td>1st Bone Spring Sand</td>
<td>10,440</td>
</tr>
<tr>
<td></td>
<td>2nd Bone Spring Shale Up</td>
<td>10,700</td>
</tr>
<tr>
<td></td>
<td>2nd Bone Spring Shale Lw</td>
<td>10,900</td>
</tr>
<tr>
<td>Permian</td>
<td>3rd Bone Spring</td>
<td>10,150</td>
</tr>
<tr>
<td></td>
<td>Upr Wolfcamp Shale A</td>
<td>10,440</td>
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<td></td>
<td>Upr Wolfcamp Shale B</td>
<td>10,700</td>
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<tr>
<td></td>
<td>Mid Wolfcamp Shale A</td>
<td>10,900</td>
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<tr>
<td></td>
<td>Mid Wolfcamp Shale B</td>
<td>11,100</td>
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<td></td>
<td>Md Wolfcamp Sand A</td>
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<td>Md Wolfcamp Sand B</td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td>Md Wolfcamp Sand C</td>
<td>12,250</td>
</tr>
</tbody>
</table>

Stacked Horizontals could significantly increase EUR’s

Wolfbone Vertical –
- ~1200’ thick.
- 108 MMboe in-place per sq. mile

© Carrollton Mineral Partners, 2012
**Going Sideways to Get Ahead**

### Horizontals in the Delaware
- Operators have been developing the 3rd Bone Spring with horizontal wells
  - Capture more acreage than vertical wells
  - More stimulated rock volume leads to higher rates
  - Larger drainage area leads to greater ultimate recovery
- Thick sections perfect for horizontal development
  - 2+ laterals per unit (Bone Spring, Wolfcamp, Avalon)
  - More laterals increases recovery factor per section

### Horizontal Wells consistently Outperform Vertical
- Vertical to Horizontal EUR factor:

<table>
<thead>
<tr>
<th>Play</th>
<th>EUR Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakken</td>
<td>3 - 5x</td>
</tr>
<tr>
<td>Eagle Ford</td>
<td>5 - 7x</td>
</tr>
<tr>
<td>Granite Wash</td>
<td>4 - 5x</td>
</tr>
<tr>
<td>Miss Lime</td>
<td>3 - 4x</td>
</tr>
<tr>
<td>Niobrara</td>
<td>6 - 8x</td>
</tr>
<tr>
<td>Wolfcamp (Midland)</td>
<td>5 - 6x</td>
</tr>
<tr>
<td>Wolfcamp (Delaware)</td>
<td>3x</td>
</tr>
</tbody>
</table>

Average ~ 5x

### Vertical vs. Horizontal Drainage Area
- **Horizontal Well = 160 Ac**
- **Vertical Well = 40 Ac**
- Source: CHK IR presentation, TPH internal research.

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Bone Spring Geologic Characterization

- The Bone Spring formation consists of 3 distinct members (deepest to shallowest):
  - 3rd Bone Spring (primary target in Reeves/Ward and Northern Eddy/Lea)
  - 2nd Bone Spring (Northern Eddy/Lea)
  - 1st Bone Spring /Avalon Shale (center basin)
- 3rd Bone Spring Sand widely distributed across basin
  - Primary target for hz development
  - Consists of 6 distinct sand facies (Hoban, A, B, C, D, E)
  - 5-10' thick and 14% porosity
  - Normally pressured - contributes to long-life production capacity of Wolfbone wells

1st Bone Spring Sand - Turbidite Channels

- 1st Bone Spring member below Avalon Shale contains turbidite channel facies in several areas
  - Similar to productive GoM turbidite channel reservoirs
The Bone Spring package exists across much of the Delaware Basin though different members are more prevalent in specific areas.
Hz Bone Spring IP Bubble Map

All completions >1,000 boe/d are less than 12 mo. old

Wells completed as Wolfbone producers after 1/1/2009 - Hoban, Wolfbone fields.
Bone Spring Industry Activity

**Bone Spring**
- Concho
  - Morning Fed. 1H
  - Test: 700 boe/d

**Bone Spring**
- Chesapeake
  - Johnson 1-86
  - 30-day: 920 boe/d

**Bone Spring**
- Chesapeake
  - Crockett 1-26 1H
  - IP rate: 2,445 boe/d

**Bone Spring**
- Chesapeake
  - Monroe 1-17 1H
  - 30-day: 1,475 boe/d

**Bone Spring**
- Anadarko
  - Blacktip Johnson 1-39H
  - 30-day: 920 boe/d

**Bone Spring**
- Cimarex
  - Davis '33-20'
  - 30-day: 1,293 boe/d

**Bone Spring**
- Cimarex
  - KHC '33-26'
  - 30-day: 1,226 boe/d

**Bone Spring**
- Cimarex
  - Talladega 65 1H
  - 30-day: 1,281 boe/d

**Bone Spring**
- Devon
  - Talladega 65 1H
  - 30-day: 1,345 boe/d

**Bone Spring**
- Chesapeake
  - Monroe 34-220
  - 30-day: 1,345 boe/d

---

(1) 3rd Bone Spring horizontal wells listed in HPDI as Phantom field, V" field.
Bone Spring Type Log Section

Gamma Ray, API

Porosity, %

Bone Spring Hoban Sand

Bone Spring A Sand

Bone Spring C Sand

Full logs available on VDR

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3rd Bone Spring Sands Net Isopach

Map Parameters
- Color contours are 10 feet (max = 50+ feet)
- Net Feet > 12% Porosity
- Reeves = up to 50’
- Mudlog shows in red (from public data)

Summary Observations
- Max net thickness on Reeves / Ward / Loving border
- Potential for comingling in vertical wells or targeting with horizontals
15 wells deviating from a standard lognormal distribution were removed from the dataset.

**Hz Bone Spring IP Rate**

![Graph showing peak 30-day rate distribution](image)

### IP Data (boe/d)

<table>
<thead>
<tr>
<th></th>
<th>Bone Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(75)</td>
<td>220</td>
</tr>
<tr>
<td>P(50)</td>
<td>397</td>
</tr>
<tr>
<td>P(25)</td>
<td>717</td>
</tr>
<tr>
<td>Mean</td>
<td>534</td>
</tr>
<tr>
<td>Count</td>
<td>73</td>
</tr>
</tbody>
</table>

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### Gas Compositional Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>Mole (%)</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2S Hydrogen Sulfide</td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td>N2 Nitrogen</td>
<td>1.096</td>
<td></td>
</tr>
<tr>
<td>CO2 Carbon Dioxide</td>
<td>0.219</td>
<td></td>
</tr>
<tr>
<td>C1 Methane</td>
<td>73.982</td>
<td>11.454</td>
</tr>
<tr>
<td>C2 Ethane</td>
<td>11.454</td>
<td>3.059</td>
</tr>
<tr>
<td>C3 Propane</td>
<td>7.352</td>
<td>2.023</td>
</tr>
<tr>
<td>NC4 n-Butane</td>
<td>2.699</td>
<td>0.850</td>
</tr>
<tr>
<td>IC4 Isobutane</td>
<td>0.887</td>
<td>0.290</td>
</tr>
<tr>
<td>NC5 n-Pentane</td>
<td>0.684</td>
<td>0.248</td>
</tr>
<tr>
<td>IC5 Isopentane</td>
<td>0.597</td>
<td>0.218</td>
</tr>
<tr>
<td>C6+ Hexanes Plus</td>
<td>1.012</td>
<td>0.438</td>
</tr>
</tbody>
</table>

**Total** 100.000 7.126

### Plant Statement Gas Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>Theoretical Recovery (%)</th>
<th>Actual (GPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2 Ethane</td>
<td>3.0591</td>
<td>70.0% 2.1414</td>
</tr>
<tr>
<td>C3 Propane</td>
<td>2.0227</td>
<td>95.5% 1.9317</td>
</tr>
<tr>
<td>NC4 Normal Butane</td>
<td>0.8498</td>
<td>97.0% 0.8243</td>
</tr>
<tr>
<td>IC4 Iso Butane</td>
<td>0.2897</td>
<td>97.0% 0.2810</td>
</tr>
<tr>
<td>NC5 Normal Pentane</td>
<td>0.2478</td>
<td>97.0% 0.2404</td>
</tr>
<tr>
<td>IC5 Iso Pentane</td>
<td>0.2180</td>
<td>97.0% 0.2115</td>
</tr>
<tr>
<td>C6+ Hexanes Plus</td>
<td>0.4384</td>
<td>97.0% 0.4252</td>
</tr>
</tbody>
</table>

**Total (GPM)** 7.1255 87.0% 6.0554

144 bbl/MMcF Recovered
Range: 123 - 177 bbl/MMcF

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Bone Spring Processing Statement

**Gross Wellhead:** 974 Mcf

**Net Residue:** 686 Mcf

**87.0% Plant Efficiency**

**Theoretical NGLs:** 7.1255 GPM

**144 bbl/MMcf NGL Yield**

**70% Residual**
The Avalon Shale is present throughout the Delaware basin and is currently being pursued as an unconventional play in the Northern half.
What is the Avalon Shale?

The Avalon Shale is the stratigraphic interval between the top of the Bone Spring formation & the 1st Bone Spring Sand.

**Basin Geology**

- Bounded by carbonate shelves & platforms
  - North: Northwest Shelf
  - East: Central Basin Platform
  - South: Marathon Fold Belt
  - West: Diablo Platform
- Bone Spring stratigraphy varies across the Delaware Basin
  - NW Shelf: predominantly carbonate
  - Slope: 1\(^{st} \)/2\(^{nd} \)/3\(^{rd} \) sandstones developing in the lower part of the interval
- Deep Basin → Avalon Shale
  - “Shale” development within the upper 1\(^{st} \) Carbonate section
  - Organic-rich siltstone and carbonate debris flow
  - Unconventional, continuous accumulation
  - 900 - 1,000’ gross thickness
Avalon Shale Net Isopach

Summary

- Map Parameters
  - Ft > 12% Density Porosity
  - GR > 75 Units
  - Resistivity > 20 ohm-m
  - From 600 data points
- Isopach is concentric from basin edges
- Porosity thick coincides with Bone Spring thick above basin low
- Primarily Pelagic deposition

Structure

- Regional Structure dips east at 100’ per mile
- 6,000’ deep in W. Eddy to 10,000’ deep in Lea County
- Lea County has more structural nosing and dip reversals than Eddy
- Axial low of basin trends N-S through Lea and Loving Counties
- GOR varies with depth with oily production in deeper basin

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Source: Net isopach map and summary bullets from John Worrall (Geologist and Partner, Bold Energy II, LLC and Manzano Energy Partners), and Chad Kronkosky (Reservoir Engineer, Bold Energy II, LLC).
Eagle Avalon Shale Isopach

105 MMboe in-place per square mile across Eagle position
Turbidite Channel Cross-Section

STRUCTURAL X-SECTION N-S

STRATIGRAPHIC X-SECTION N-S
Texas Avalon / Bone Spring Production Increasing

Production growth expected to continue recent momentum given industry focus on liquids and public statements from operators

Cumulative Production 96 MMboe

First Avalon Shale Horizontal Producer
Chesapeake PLU Pierce Canyon 17-1H
First Production: January 2009
Peak Rate: 656 boe/d

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Source: HPDI. Includes vertical and horizontal wells with a target reservoir of Bone Spring or Avalon (HPDI does not currently distinguish between the zones) in the following counties: Reeves, Loving, Ward, Pecos, Winkler
Eagle Oil & Gas, Co.

WolfBone Play
Southern Delaware Permian Basin


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