Water Usage in the Permian Basin: Drilling and Fracturing without Fresh Water

AAPG Global Super Basin Conference – The Permian
January 23rd - 24th, 2019
Stonnie L. Pollock, Senior Geologist, Fasken Oil and Ranch
Outline

• Location: Midland Basin – CB Platform
• Fasken Operations
• Aquifers of West Texas
• Dockum Geology
• Santa Rosa Water Production & Treatment
• Produced Water Treatment/Recycling
• Permian Basin Water Usage
Fasken Operations

- **C Ranch Acreage Position**
  - 250 mi² – 166,000 acres

- **Wolfberry Drilling Program**
  - 2008 to Present
  - 700 Wolfberry Wells
  - 17 Wolfberry Horizontals
  - 2019 Manor Park Project

- **Drilling & Fracing Water Usage**
  - Began with Fresh Groundwater (Ogallala)
  - 2013 Begin Producing and Treating Santa Rosa Water from the Dockum Aquifer
  - 2013 Begin Transitioning from SWD to Treated/Recycled Produced Water
  - Vertical vs. Horizontal
    - Volume: 50,000 bbls to 500,000 bbls
  - Larger Frac Pits
Uppermost Leonardian and Guadalupian Section – From NCU to MFU to Mabee
Aquifers of Texas

Ogallala Aquifer

Edwards Trinity Aquifer

Dockum Aquifer

Dockum Geology

- Ogallala
- Upper Dockum
- Santa Rosa
- Lower Dockum
- Rustler
Brown (2016), Modified from Dickinson and Lawton (2001)
Tectonics and Sedimentation of the Dockum

Brown (2016), Modified from McGowen, Granata, and Seni (1977)

Brown (2016)
Santa Rosa Sandstone

Top Santa Rosa

Isopach Santa Rosa
Open-Hole Logging of the Santa Rosa
Santa Rosa Water Sand
Santa Rosa Water Production

- Fasken Operates 14 Wells
  - 4 Plugback/Re-Entries
  - 10 Drilled
  - 3 Inactive
  - 5 New Wells
    - Currently Testing
    - See Wellbore Diagram
- Depth = 1,600’
- Average Interval = 1,100’-1,500’
- Current Production = 24,160 BWPD
- Drilled and Equipped Cost = $225,000
- Average Rate = 2,500 BWPD
- Production Cost = $0.09 per raw bbl
Santa Rosa Water Treatment – RO Facility
Santa Rosa Reverse Osmosis Water Treatment

- Average RO Feed = 3,964 BWPD
- Average Rejection = 1,467 BWPD
- Average Production = 2,498 BWPD
- 2018 Production = 911,624 BW
- Treatment Cost = $0.29 per bbl
- Usage = Drilling, Cementing, and Camp Water
- Brine Water for Drilling Salt Section
  - Purchase about 1,500 BW, then reuse

- Water Per Well
  - 11,500’ Vertical Wolfberry Well = 4,000 BW
  - 20,000’ Horizontal = 10,000 BW
  - Cementing = 500 – 1000 BW
  - Camp Water = 500 BW
Santa Rosa - Reverse Osmosis Water Treatment

### Raw Water

<table>
<thead>
<tr>
<th>Field Data</th>
<th>Analysis of Sample</th>
<th>Anions: mg/L</th>
<th>mmol/L</th>
<th>Cations: mg/L</th>
<th>mmol/L</th>
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<td>Initial Temperature (°F):</td>
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<td>Chloride (Cl⁻):</td>
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<td>Sulfate (SO₄²⁻):</td>
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<td>Potassium (K⁺):</td>
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<td>Initial Pressure (psig):</td>
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<td>Borate (Na₂B₄O₇):</td>
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<tr>
<th>Alkalinity by Titrations: mg/L</th>
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<td>Micarbonate (HCO₃⁻):</td>
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<td>Carbonate (CO₃²⁻):</td>
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<td>Hydroxide (OH⁻):</td>
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<th>Sample Specifics: g/L</th>
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<td>Phosphate (PO₄³⁻):</td>
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**Anion EPM Total:** 69 | **Cation EPM Total:** 80

**N/A - Not Applicable**

### Treated Water

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<td>pH:</td>
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<td>Phosphate (PO₄³⁻):</td>
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**Anion EPM Total:** 17 | **Cation EPM Total:** 4

**N/A - Not Applicable**

% RPD of Cations/Anions: 15.9%
1. Raw produced water from field into T7 & T8 for equalization.
2. Surge pumped from T9 to Gun Barrel for separation.
3. GB to T1 through recycle pump to ClO₂ Generation Plant to maintain constant flow rate.
4. Generate ClO₂ by hitting with Chlorite, Bleach and HCl.
5. Water run into Weir tanks for settling and splitting.
6. Slop skimmed and disposed.
7. Water run to Tanks 2-6 for more equalization to remove remaining solids and hydrocarbons.
8. Water from tank 6 is also used for ClO₂ generation.
10. Water to Frac Pit.
Fee BM SWD Water Recycling Facility

Battery for separation and equalization

Weir tanks for settling and splitting
Fee BM SWD Water Recycling Facility

CIO² Generation Plant
Fee BM SWD Water Recycling Facility

Slop Tank

Skimming Slop

Splitting Water through Weir Levels
Fee BM SWD Water Recycling Facility

Filter Pods:
16 - 10 micron socks
16 - 5 micron socks
## Inlet-to-Pit Chemistry

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<th>ClO2 Dosage</th>
<th>Before Weir ClO2 Res</th>
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<th>To Pit pH</th>
<th>Inlet ORP</th>
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<th>Inlet Iron (mg/L)</th>
<th>After Weir Iron (mg/L)</th>
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<th>Inlet TDS (mg/L)</th>
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</table>
Fee BN Treatment Frac Pits – 800,000 bbls per pit
Produced Water Treatment - Recycling

- Current Procedure: Treated Produced Water mixed with Raw Santa Rosa Water
- Capacity at Fee BN Pit to Treat Produced Water = 15,000 BWPD
- Current Production = 8,092 BWPD
- Current Raw Santa Rosa Mix Volume = 3,782 BWPD
- Total Frac Water = 11,874 BWPD
- 2018 Treated Production = 2,223,603 BW
- Total 2018 Frac Water = 3,603,895 BW
- Treatment Cost = Ave. $0.60 bbl
- SWD Cost (public) = $0.75 bbl
- Beginning in 2013, Fasken eliminated the use of Fresh Groundwater for Drilling & Fracing
  • Exceptions.....?
Fee AA Frac Pit Liner & Leak Detection

**DIRECTIONS**

1. Lay out and mark the pit line.
2. Dig trenches for the liner and drainage channels.
3. Install the liner and drainage channels.
4. Backfill with compacted soil.

**SPECIFICATIONS**

- **Liner**
  - HDPE certified liner
  - 60 mil.
- **Drainage Net**
  - 200 mil.
- **Geo-Textile**
  - 12 oz.

**PROCEDURE**

1. Lay out the pit line and mark the corners.
2. Dig the trenches for the liner and drainage channels.
3. Install the HDPE certified liner.
4. Install the drainage net.
5. Install the geo-textile.

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**DIRECTIONS**

1. Lay out and mark the periphery of the pit.
2. Dig trenches for the liner and drainage channels.
3. Install the liner and drainage channels.
4. Backfill with compacted soil.

**SPECIFICATIONS**

- **Perforated Poly Tee**
  - 6" Poly Tee
  - DR 11
- **Leak Detection**
  - 6" Leak detection laid into wall covered by top liners

**PROCEDURE**

1. Lay out the pit line and mark the corners.
2. Dig the trenches for the liner and drainage channels.
3. Install the liner and drainage channels.
4. Install the perforated poly tee.
5. Install the leak detection system.

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**River Rock**

- **Liner Detail**
- **Location**
  - Armidale County
  - Fee AA, Section 21
- **FASKEN OIL AND RANCH LTD**
  - 4051 HOLLOW HILL ROAD
  - MELBOURNE, TX 77362 USA

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**FASKEN OIL AND RANCH LTD**
- 4051 HOLLOW HILL ROAD
- MELBOURNE, TX 77362 USA
**Water Management**

**Basin Comparison**

<table>
<thead>
<tr>
<th>Play</th>
<th>Fracs/month</th>
<th>Bbl/frac</th>
<th>% Slickwater</th>
<th>Produced Water Recycling</th>
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<tr>
<td>Marcellus</td>
<td>90</td>
<td>275,000</td>
<td>95</td>
<td>Most produced water is recycled</td>
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<tr>
<td>Bakken</td>
<td>90</td>
<td>200,000</td>
<td>70</td>
<td>Nearly no recycling</td>
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<tr>
<td>SCOOP &amp; STACK</td>
<td>100</td>
<td>275,000</td>
<td>50</td>
<td>Recycling is being planned and growing</td>
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<td>Eagle Ford</td>
<td>160</td>
<td>250,000</td>
<td>55</td>
<td>Very little recycling</td>
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<tr>
<td>Permian</td>
<td>400</td>
<td>500,000</td>
<td>55</td>
<td>About 30% and growing</td>
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**Slickwater Comparison**

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<th>% Slickwater 2016</th>
<th>% Slickwater 2018</th>
<th>Produced Water Recycling</th>
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<td>Marcellus</td>
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Acknowledgements

• Fasken Oil and Ranch, Ltd.
• Bo Farris, Facilities Engineer, Fasken
• AAPG – Super Basin Conference
Thanks – Questions?