Oklahoma Governor’s Water Conference – Oct 31, 2017
Water Management in Oklahoma Oil and Gas

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Outline

1. History of water management in shale plays
2. Benefits and Challenges
3. Infrastructure examples
4. OWRB Oklahoma study
5. New studies
Water Lifecycle for Oil and Gas Production

Important Aspects:

- Sourcing
- Disposal
- Re-use
- Transport
History of Water for Unconventionals

• Barnett Shale - drilling - late 1990s
• Water management - an after-thought
• Local groundwater or surface water sources
• 2005 - new plays – economic viability
• 2010 - horizontal rigs 900+ = Sustainability
Water Management – Challenges Emerge

• EPA - 2010 - study of potential impacts of hydraulic fracturing
• 2011 & 2012 - Oklahoma - drought
• 2014 Ceres - unconventional development & water stress
• Induced seismicity - concern in OH, AR, TX & OK
Water Management Forecast

Short Term

• Few restrictions on sourcing
• Limited restrictions on disposal

Long Term

• Expect volatility (droughts, disposal limits, activity spikes)
• Water planning needed
Objectives of Water Management (Companies & Public)

1. Maintain or reduce lifecycle costs
2. Use distant non-fresh sources – brackish or municipal
3. Aggregate volumes: economics of scale with treatment
4. Reduce trucking

Stakeholder support
Challenge to Re-use

1. Cost: transport & treat
2. Right-of-way & landowner
3. Legal
   a. Selling water between producers
   b. Environmental liability if transferred
   c. Water for re-use in other industry
4. State regulations
5. Federal Rules for Discharge
Oklahoma Water Infrastructure for Oil and Gas

- Continental Res. - water recycling facilities in 2 areas.

- Newfield Exploration –
  - 160 miles of water pipelines.
  - New plant announced for Kingfisher Co.
Oklahoma Water Infrastructure for O&G (Cont.)

• Devon Energy –
  • Initiated a water re-use system
  • Includes a network of pipelines
  • Deal with OKC to use treated wastewater

• Chesapeake & White Star
  • Pipe networks – reduce trucking
Oklahoma Initiatives

- OK Corp. Comm. (OCC) - reduced water disposal.
- Governor Fallin established committee for produced water.
- OWRB & CH2M - study of re-use options.
1. Re-use by the oil and gas industry is the most cost-effective alternative to injection in disposal wells.

2. Surplus produced water in Alfalfa County could be gathered and conveyed to Blaine County for re-use.

3. Evaporating produced water is the third most cost-effective alternative category.

4. Desalination for power, industrial plants or discharge to rivers is technically implementable, but is the most expensive.
Re-use Summary - Recommendations

1. Reduce the challenges to re-use via targeted legislation.
2. Continue to facilitate the re-use of produced water
3. Continue study of transferring the Miss. Lime produced water to the STACK
4. Continue evaluation of evaporation
5. Consider all negative and positive environmental and stakeholder impacts
Produced Water in Oil and Gas Operations

High produced water volumes in dark blue

Large water users in red and green

Matching Produced Water with potential users.
Produced Water in Oil and Gas Operations

- Water quality needed for oilfield reuse is flexible.
- Water for other industries or discharge requires desalination.
- Transportation of water can be high cost
# Produced Water Re-use Scenarios

<table>
<thead>
<tr>
<th>New Case</th>
<th>Case Description</th>
<th>Total Capital ($Millions)</th>
<th>Capacity BWPD</th>
<th>County</th>
<th>Assumed Wtr TDS (mg/L)</th>
<th>Normalized $/BW</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Typical Source and Dispose - STACK &amp; SCOOP</td>
<td>NA</td>
<td>NA</td>
<td>Central OK</td>
<td>NA</td>
<td>1.09</td>
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<tr>
<td>2</td>
<td>Oil and gas re-use (treatment cost only)</td>
<td>NA</td>
<td>NA</td>
<td>State-wide</td>
<td>NA</td>
<td>0.57</td>
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<tr>
<td>3</td>
<td>Clean Brine Transfer &amp; treatment</td>
<td>208</td>
<td>200,000</td>
<td>Alfalfa</td>
<td>17,000</td>
<td>1.03</td>
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<tr>
<td>4</td>
<td>Evaporation - low TDS (SCOOP &amp; STACK)</td>
<td>NA</td>
<td>20,000+</td>
<td>Blaine</td>
<td>17,000</td>
<td>1.66</td>
</tr>
<tr>
<td>5</td>
<td>Evaporation - high TDS (Miss. Lime)</td>
<td>NA</td>
<td>20,000+</td>
<td>Alfalfa</td>
<td>213,000</td>
<td>1.79</td>
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<tr>
<td>6</td>
<td>Desalination for Surface Discharge</td>
<td>22</td>
<td>15,000</td>
<td>Beckham</td>
<td>9,000</td>
<td>3.58</td>
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<tr>
<td>7</td>
<td>Desalination for Power Use</td>
<td>88</td>
<td>130,000</td>
<td>Pawnee</td>
<td>125,000</td>
<td>4.37</td>
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<td>8</td>
<td>Desalination for Industrial Use</td>
<td>35</td>
<td>50,000</td>
<td>Grant</td>
<td>227,000</td>
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<tr>
<td>9</td>
<td>Desalination for Surface Discharge</td>
<td>38</td>
<td>30,000</td>
<td>Grant</td>
<td>227,000</td>
<td>7.49</td>
</tr>
</tbody>
</table>

*Without transportation included, re-use costs less than sourcing and disposing.*

*New transfer lines will allow re-use to grow.*

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**Short term**, **Medium term**, **Long term**

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Without transportation included, re-use costs less than sourcing and disposing. New transfer lines will allow re-use to grow.
OWRB Ongoing Study

- Using US Bureau of Reclamation Grant
  - Study of water transfer
  - Study evaporation option

- Partners

- Collaboration with PWWG and industry
GWPC National Produced Water Report

- Scope of work
  - Regulations
  - Re-use within oil and gas
  - Recycling for use in other industries
- Collaboration with regulators and industry
  - OWRB, ODEQ and CH2M involved
- Study to extend throughout 2018

Groundwater Protection Council

- Based in OKC
- Non-profit working with regulators and industry
- Worked national water issues including FracFocus & seismicity
Thank You