Development of Water Use Estimates and Projections in the Texas Mining and Oil and Gas Industries (FY2020)
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Oil and Gas

- Task 1. Quantify current and historical water use for **hydraulic fracturing and produced water** volumes
- Task 2. Identify the **sources of water** for hydraulic fracturing
- Task 3. Develop **projections** of future water demand for hydraulic fracturing for oil & gas (2030–2080)

**Coal, Lignite, and Aggregates**

- Task 4. Identify locations of operations and quantify current and projected future water use for **coal and lignite** mining
- Task 5. Identify locations of operations and quantify current and projected future water use for **aggregates**

**Coordination:**

- Task 6. Collaborate with **USGS personnel** on water use for the mining category
Task 1. Quantify current and historical water use for hydraulic fracturing and produced water volumes

**Hydraulic Fracturing**
- Data sources for HF water use: FracFocus and IHS
- Time period: 2009 – 2020
- Permian, Eagle Ford, Barnett, and Haynesville
- Surveys to estimate water reuse

**Produced water volumes**
- Data sources: IHS database
- Time period: 2009 – 2019
- Focus on wells in unconventional reservoirs
Hydraulic Fracturing Water Use (2010 through 2019)
Horizontal Well Depths (2010 – 2019)
Hydraulic Fracturing Water Use per Well

Delaware Basin

Midland Basin

Hydraulic Fracturing Water Use per Well

HF (10^6 L/well)

HF (10^6 gal/well)
Hydraulic Fracturing Water Intensity per Foot of Lateral

Delaware Basin

Midland Basin

HF (10^3 L/m)

HF (10^3 gal/ft)
Proppant Loading per Foot of Well Lateral
Comparison of water volumes for HF from TWDB FracFocus and BEG IHS (2019)

<table>
<thead>
<tr>
<th>TWDB Play</th>
<th>TWDB FF mgal</th>
<th>BEG mgal</th>
<th>Counties</th>
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<tbody>
<tr>
<td>Anadarko</td>
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<td>354</td>
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<tr>
<td>Barnett</td>
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<td>366</td>
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<td>Bossier</td>
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<td>Total</td>
<td>103,583</td>
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Produced Water Volumes in the Permian Basin (Conventional vs Unconventional Reservoirs)

Permian Basin

Annual volume ($10^9$ L)

- Total PW
- Conv PW
- Unconv PW
- HF
b) Midland Basin

Annual volume (10^9 L)

- Total PW
- Conv PW
- Unconv PW
- HF


(10^9 gal)

c) Delaware Basin

Annual volume (10^9 L)

- Total PW
- Conv PW
- Unconv PW
- HF


(10^9 gal)
Produced Water to Oil Ratio and Water Cut

a) PWOR

b) PWOR

c) Water cut (%)
d) Water cut (%)
Task 2: Source Wells to Supply Water for Hydraulic Fracturing
Depth of Rig, Frac, and Industrial Wells (2010 – 2019)
Rig, Frac, and Industrial Wells in Major Aquifers

2010 - 2019
Rig, Frac, and Industrial Wells in Minor Aquifers

2010 - 2019
Comparison of Well Drilling for Rig/Frac/Industrial Supply relative to Other Sectors
Comparison of Well Drilling for Rig/Frac/Industrial Supply relative to Other Sectors

Pecos Valley

Diagram showing the number of wells completed from 2010 to 2019 for domestic, stock, public supply, irrigation, and rig/frac/injection (Rig/Frac/Injd) sectors.
Water Quality in the Ogallala and Pecos Valley Aquifers
Water Quality in the Edwards-Trinity Plateau Aquifer
Task 3. Develop projections of future water demand for hydraulic fracturing for oil & gas (2030–2080)

- **Projected well inventory** for unconventional reservoirs
- Technically Recoverable Resource estimate (TRR, assuming all potential wells will be drilled)
- Consider recent well spacing and vertical stacking to develop projections
- Spatial resolution (well inventory/mi$^2$)
- Expand on previous projections for water demand for hydraulic fracturing for the Permian Basin, Barnett, Eagle Ford, and Haynesville plays

- Texas Oil and Gas Association: workgroup to provide input
Will Water Issues Constrain Oil and Gas Production in the U.S.?

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- Oil plays in semiarid W U.S.; gas plays in humid east
- PW from oil reservoirs >> than that from gas reservoirs
  Permian PW = 50× Marcellus PW
- Partially mitigate water sourcing and disposal issues by reusing PW for HF
- Projected PW volumes = ~ 4× HF water demand in the Delaware

https://pubs.acs.org/doi/10.1021/acs.est.9b06390
Highlights

- Irrigation demand exceeds produced water (PW) volumes and could accommodate treated PW.
- Treated PW could also be used to recharge depleted aquifers if there was confidence in the treatment process.

Scanlon, B. R. et al. Can we beneficially reuse produced water from oil and gas extraction in the U.S.? *Science of the Total Environment*  
Future Work

• Analysis of reuse of produced water for hydraulic fracturing
• Comparison of water use data for oil and gas from USGS with results from this study
• Impact of water use for hydraulic fracturing on water resources (focus on Permian Basin hydrographs)
• Projections of future water demand for hydraulic fracturing based on technically recoverable resources
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