30 YEARS OF ENERGY DATA INNOVATION

Transforming complex data into actionable, high value intelligence for responsible and profitable decisions about water resources and the water services market.
Provide comprehensive assessment of Permian Basin water utilization to address future water management approaches.

I. Derive estimates of future:
   - Water use
   - Water production
   - Available disposal capacity

II. Assess water management business structure:
   - Range of appropriate solutions
   - Identification of best practices
   - Consideration of appropriate economies of scale
   - Impacts of technology
I. Permian Basin water budget (study inputs/assumptions):
   ▪ Oil & gas production forecast
   ▪ Water use forecast
   ▪ Water production forecast

II. Current activities:
   ▪ Water production validation
   ▪ Pressure forecasts
Oil+Gas Production Forecast
High price scenario: Drillinginfo 3Q18 forecast
Low price scenario: CME forward curve 11/17/2018
Most major Permian Basin producers operate Tier 1 and 2 properties with half-cycle breakeven costs <$55

Source: Drillinginfo ProdCast and B3
Permian Basin Production Scenarios

8-10 mmboe/day forecasted Permian Basin production by 2029

High price scenario
Low price scenario

Source: Drillinginfo Prodcast and B3
Water Use Forecast Methodology

Production/Month (Forecasted) \( \times \) Wells Drilled/Month \( \times \) Average Water Use/Well = Water Use/Year

- 10 Subareas
- 37 Different Sub-Subareas (e.g., Bone Springs, Spraberry, Wolfcamp)
- 3 Tiers Based on DI Estimates of Breakeven Price
Permian Basin Drilling Scenarios

Higher price scenario drives development of ~50% more wells by 2028

Source: Drillinginfo and B3
Water Use (2017)

Source: FracFocus and B3
Permian Basin Forecasted Water Use

### Water Use (mmbbl/day)

**High price scenario (mean)**
- 2019: 1.2 Bbbls
- 2020: 0.9 Bbbls
- 2023: 0.9 Bbbls
- 2028: 1.8 Bbbls

**High price scenario (median)**
- 2019: 1.2 Bbbls
- 2020: 0.9 Bbbls
- 2023: 0.9 Bbbls
- 2028: 1.2 Bbbls

**Low price scenario (mean)**
- 2019: 1.2 Bbbls
- 2020: 0.9 Bbbls
- 2023: 0.9 Bbbls
- 2028: 1.2 Bbbls

**Low price scenario (median)**
- 2019: 1.2 Bbbls
- 2020: 0.9 Bbbls
- 2023: 0.9 Bbbls
- 2028: 1.2 Bbbls

Source: FracFocus and B3
Water Production Forecast
Permian Basin Forecasted Water Production

Water:BOE
Mean = 1.90:1

Low Price Scenario

Source: B3
Production and Use Comparison

Source: B3
• Production economics in the Permian Basin are generally sub-$55 half-cycle breakeven in many Tier 1 and Tier 2 areas.

• Given the likelihood that prices fluctuate between $55 and $75 for the foreseeable future, water demand for hydraulic fracking will be between 0.9 and 1.8 Bbbls per year.

• Dependent on number and location of new wells, produced water volume is expected to exceed maximum water demand by 3x-5x for the given production scenarios.

• Over the next decade, 35-60 B bbl of water in excess of water use for hydraulic fracturing will need to be managed. Reuse is, at best, a partial solution.
Current activities
Water Production Validation

- P-18 (Skim Oil/Condensate Report) provides water, oil, and condensate amounts received at commercial disposal facilities from producing properties.
- Data collected in platform being used to derive monthly lease-level water production and WOR.
Empirical/anecdotal evidence suggests increasing pressure and seismic activity due to subsurface produced water disposal.

Pressures increases are expected to be both local (generally transitory) and distributed (more persistent), influenced by the rate of fluid injection, the cumulative volume of fluid injection, and associated rock properties.

Basin-wide description/prediction of spatial and temporal pressure is currently hindered by lack of aggregation/analysis of available geologic and injection data.

“The San Andres Problem” (Guidon)

Pressure/Rate Limits

Permian Basin (Texas)

- Number of Wells: 101, 67, 101, 102, 85, 54, 38, 29, 13, 15
- Fraction of Permitted Pressure
  - Mean: 0.36
  - Median: 0.34
  - $\sigma^2$: 0.24

- Number of Wells: 238, 156, 89, 53, 26, 20, 12, 8, 2, 1
- Fraction of Permitted Rate
  - Mean: 0.19
  - Median: 0.14
  - $\sigma^2$: 0.17
Pressure Modeling

• B3 is using industry standard groundwater flow simulation software to generate pressure forecasts at Basin and subarea scales.

• Models to account for static/dynamic formation and fluid properties and be calibrated to historical fluid injection/pressure response.

• Results intended to be used to address the nexus of localized, near-wellbore pressure perturbations due to active injection and larger-scale, background pressure changes attributed to cumulative disposal.

Pressure Modeling for Capacity Estimation

Inputs:
• Basin structure
• Basin stratigraphy
• Basin rock and fluid properties
• Injection rates/cumulative volumes
• Downhole pressure
• Well properties/distribution
Absolute Water Disposal (2010-2017)