# Leveraging economics for effective produced water management

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# Agenda

- Produced Water Overview
- Challenges and Opportunities
- Oilfield Water Management
- Decision-making
- Case Example
- Conclusions
- Questions

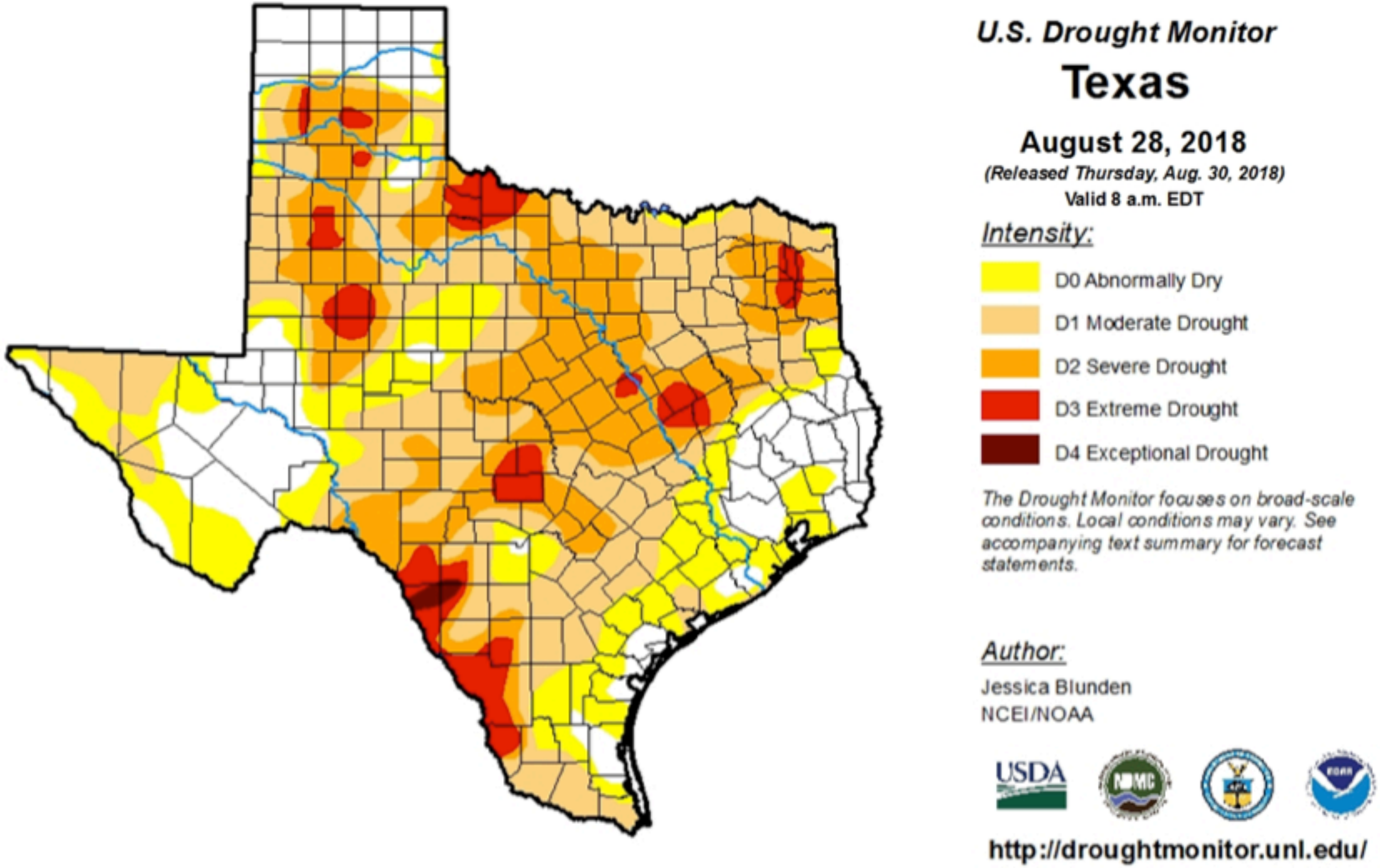
# Produced Water

Produced water originates in underground formations and is brought to the surface during oil and gas production.

- Complex composition
- Flows and volumes vary
- Impacts infrastructure
  - Scaling
  - Corrosion
  - Erosion
  - Fouling
  - Hydrogen sulfide gas production

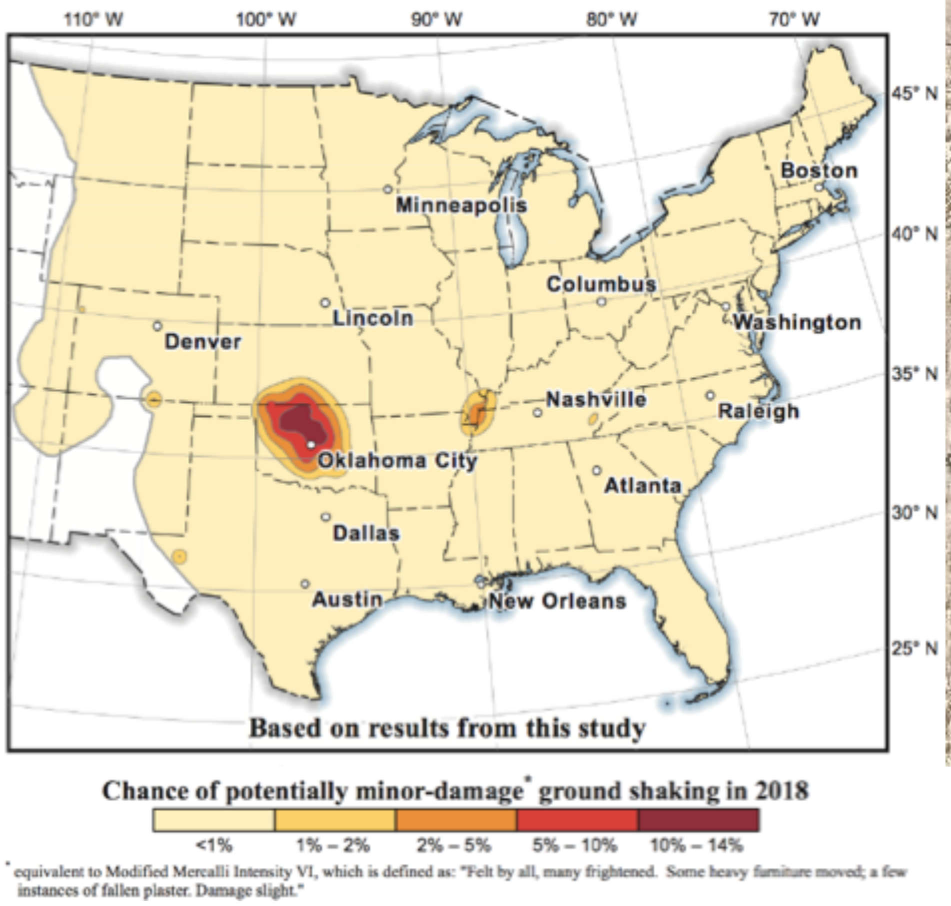
# Opportunities

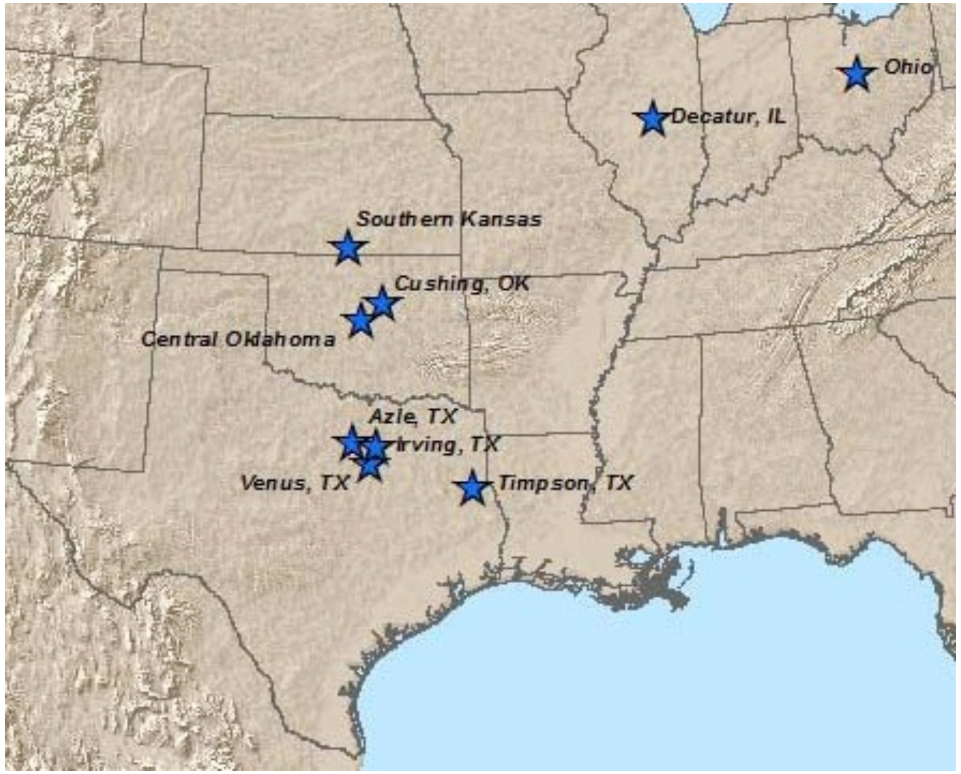
Large water volumes are needed for hydraulic fracturing.
Reusing produced water for fracking reduces demand on local water supplies.



# Opportunities

Minimizing produced water disposal reduces induced seismicity risk.



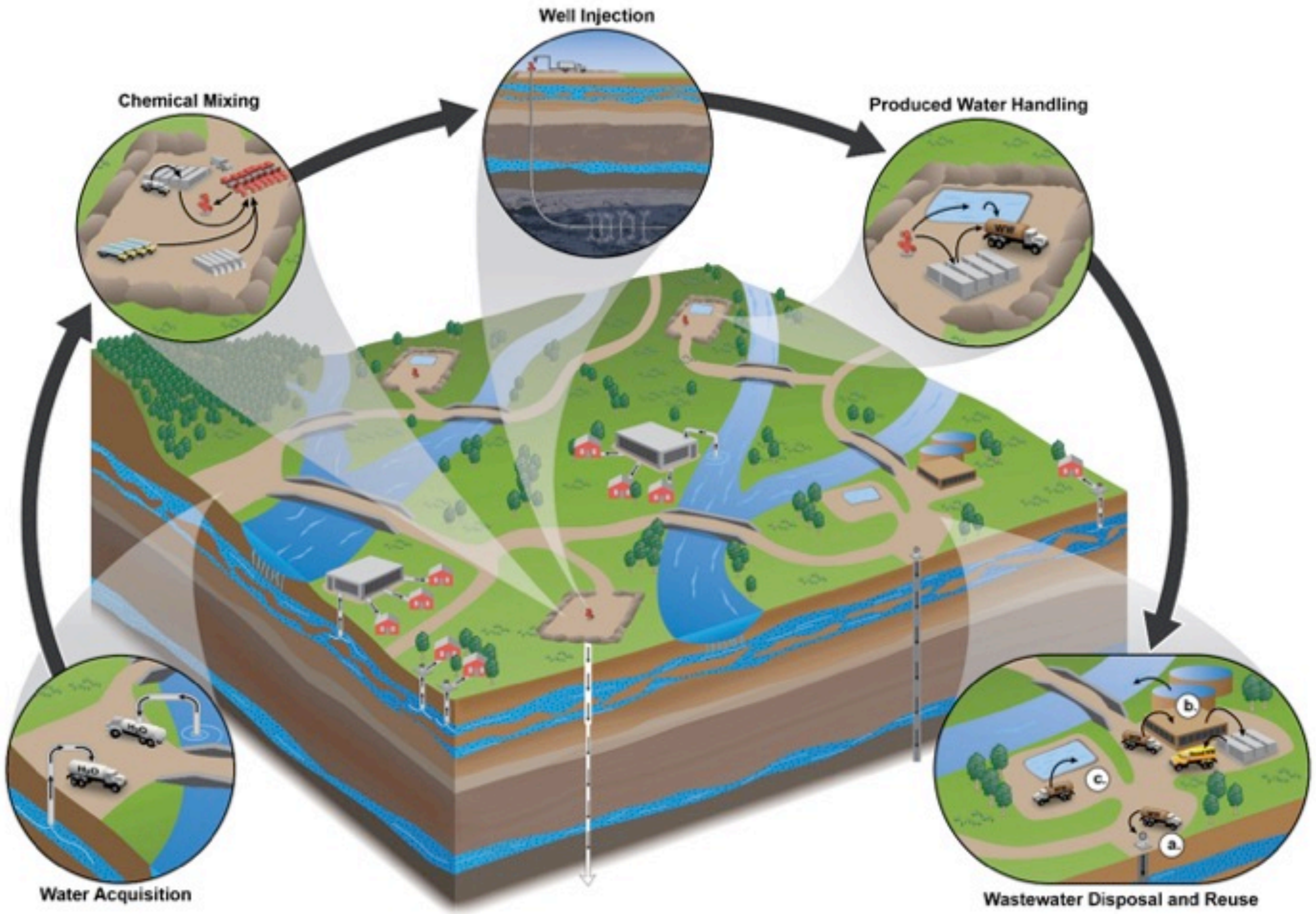




Locations of USGS temporary seismic deployments

USGS 2018

# Oilfield Water Cycle

Water affects oilfield logistics, and becomes more complex as fields develop.




**Field Development (Walsh 2013)**

**Stage 1:**
Remote, isolated wells.

**Stage 2:**
Well clusters with some infield drilling and completions.

**Stage 3:**
Extensive in-field development.

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U.S. EPA 2016, Walsh 2013

# Water Management Decision-making

All produced water management decisions come with costs.
Economics enables options comparison and arrival at appropriate solutions.

**Source**

**Convey**

**Store**

**Reuse**

**Treat**

**Dispose**

# What have we done before?

Trade-off evaluations can be time-consuming, cumbersome, and incomplete.

## Methods

- Rigorous designs
- In-house models
- Consulting studies

## Challenges

- Quality of information
- Geographic specificity
- Operating time horizons
- Integration of disparate factors

## Sensitivities

- Oil price
- Drilling Schedule
- Good and service cost fluctuations

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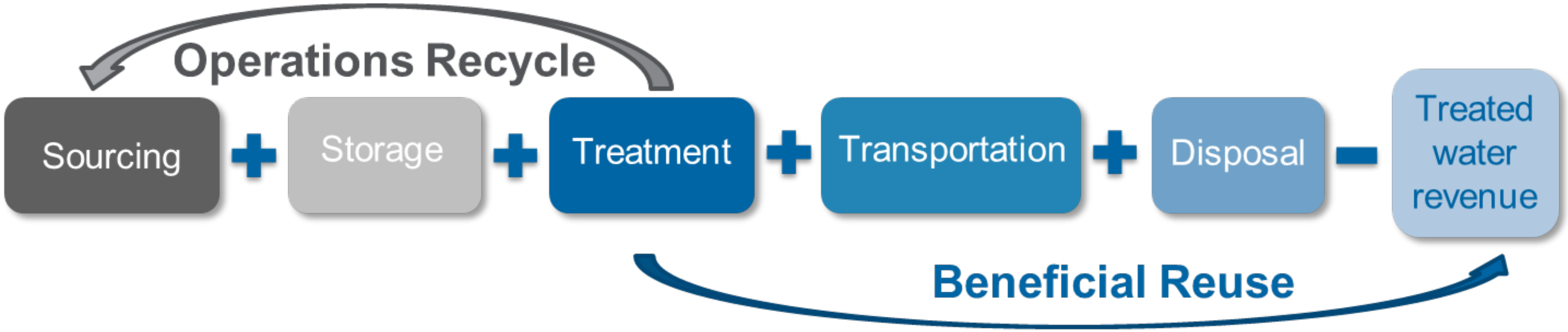
# What can we accomplish today?

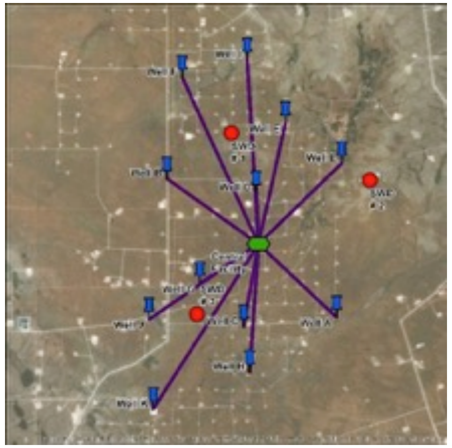
**Economic modeling allows for rapid, equivalent, and relevant options analysis.**




Wells to Central - Trucking

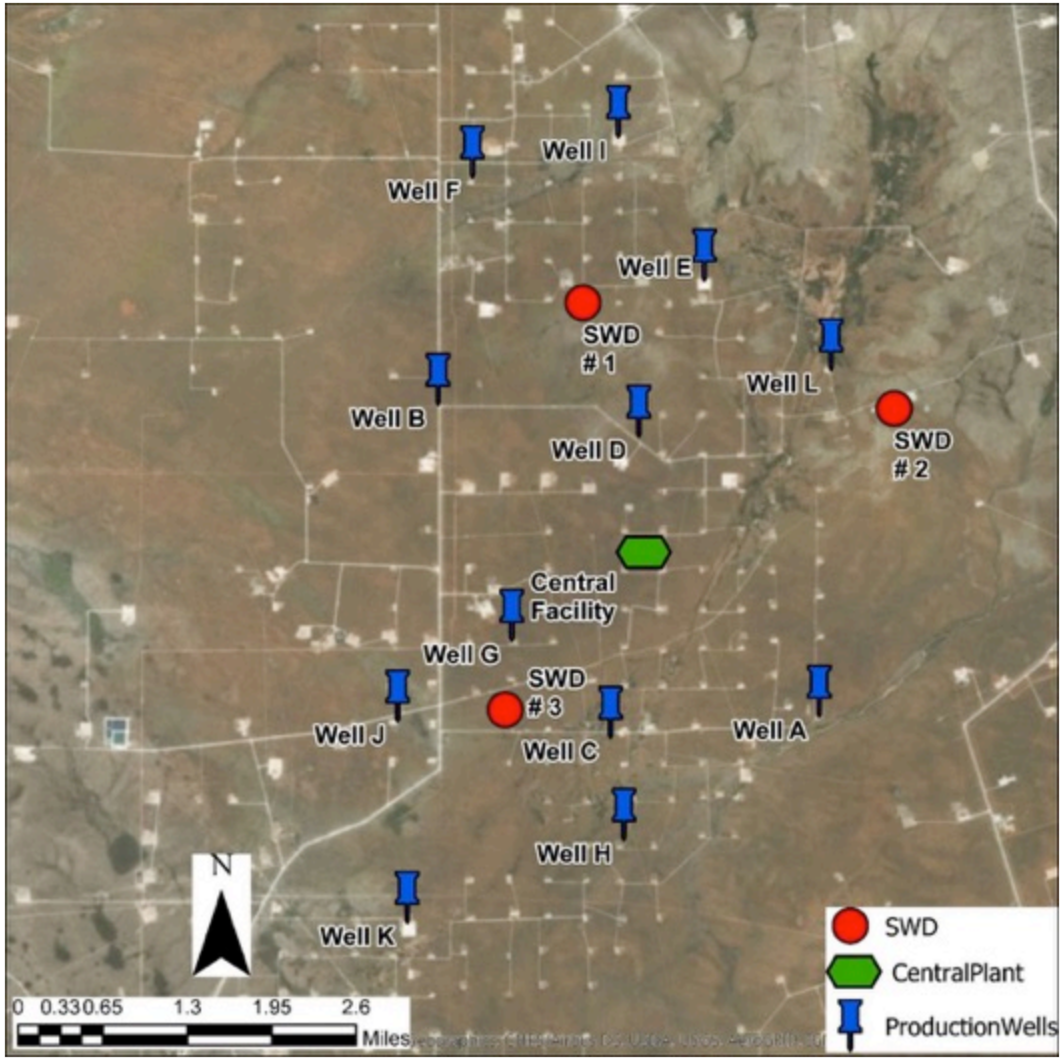
Wells to SWDs - Trucking

Wells to Central - Pipeline



Central to SWD - Trucking

# Example: Infield Development



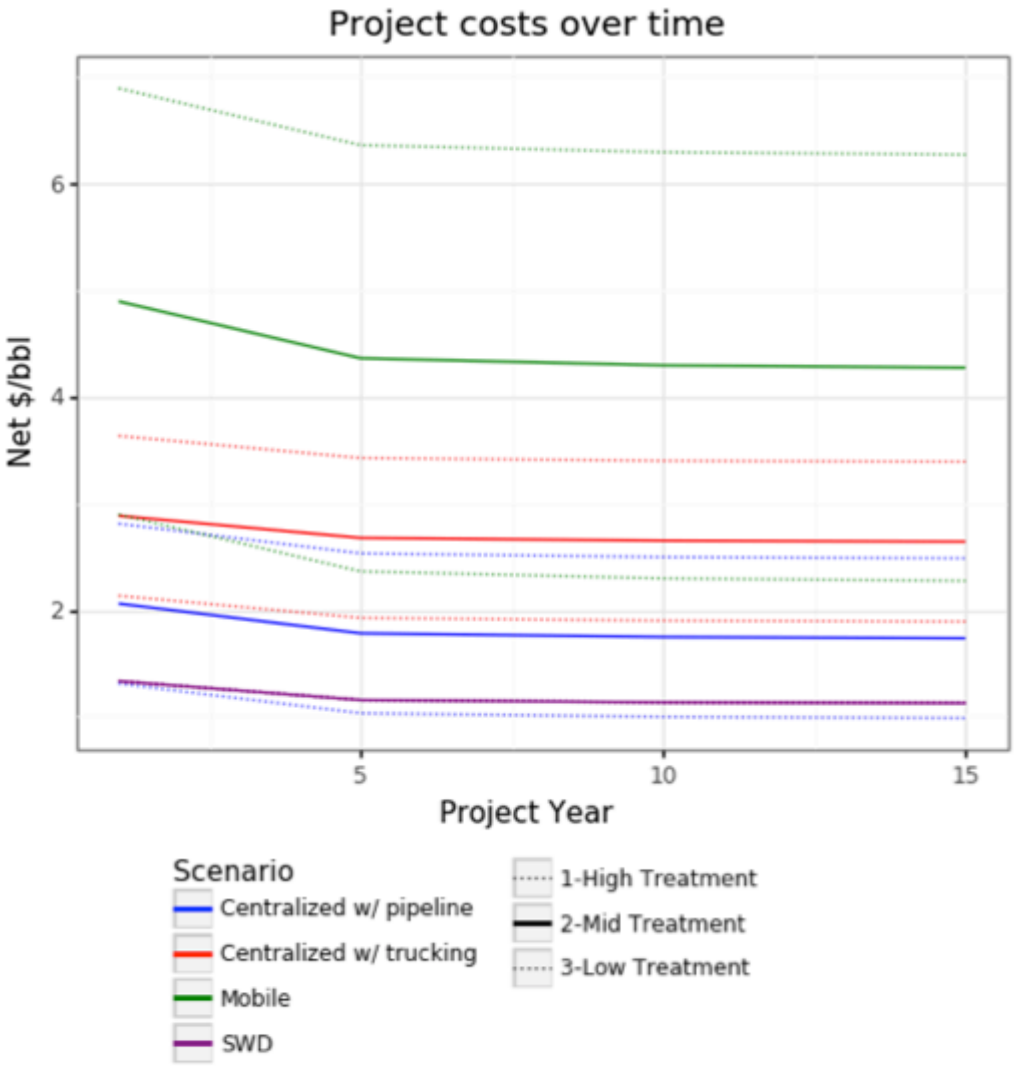

**Assets:**
- 12 Production Wells
- 3 Salt water disposal wells (SWDs)
- 1 Centralized Treatment Plant

**Treatment Assumptions:**
- 50% uncertainty applied
- Mobile $2 - $6 per barrel
- Centralized $0.75 - $2.25/bbl

**Other Logistics Assumptions:**
- 30-year project lifespan
- Injection Cost $0.30/bbl
- Trucking Cost $75 per hour
- Reuse savings $0.65/bbl

# Results

**A phased approach will enable holistic, cost-effective field development.**




**Years 0 – 5:**

- SWDs are most economical for produced water disposal.
- Centralized + pipe < mobile.

**Years 5 – 15:**

- Centralized + pipe < mobile.
- Centralized + pipeline competes with SWDs when trucking costs are low.

**Strategy:**

- Phased approach
- Year 1 – 5: SWDs
- Shift to centralized treatment.
- Consider options to reduce desalination costs.

# Conclusion

- Produced water is a critical bottleneck.
- Effective management can achieve operational, economic, safety, environmental, and sustainability goals.
- Sourcing, storage, treatment, transportation, reuse and disposal comprise key decisions.
- Current methods are time-consuming, cumbersome, and incomplete.
- Economic modeling enables rapid, equivalent, and relevant analysis.
- Economics can drive creative solutions.

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# Questions?

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