# A Water Budget Perspective to Produced Water Management

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Produced Water Research Consortium - 2022 Annual Meeting
Las Cruces, New Mexico
Tuesday, December 6th, 2022

NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE

NM STATE UNIVERSITY

# New Mexico Water Resources Research Institute -History


## Established in response to drought of 1950s in New Mexico

- 1956 First annual New Mexico Water Conference

## Long history of supporting statewide water research

- 1963 NM WRRI established

## Special relationship with nationwide network of water institutes

- 1964 Water Resources Research Act set up network of water research institutes

  (one in every state plus three territories and the District of Columbia ; PL 88-379.2 introduced by NM Senator Clinton P. Anderson modeled on NM WRRI)

## Statewide mandate

- NM WRRI statewide cooperation with New Mexico State University, the University of New Mexico, New Mexico Institute of Mining and Technology, New Mexico Highlands University, Eastern New Mexico University and Western New Mexico University

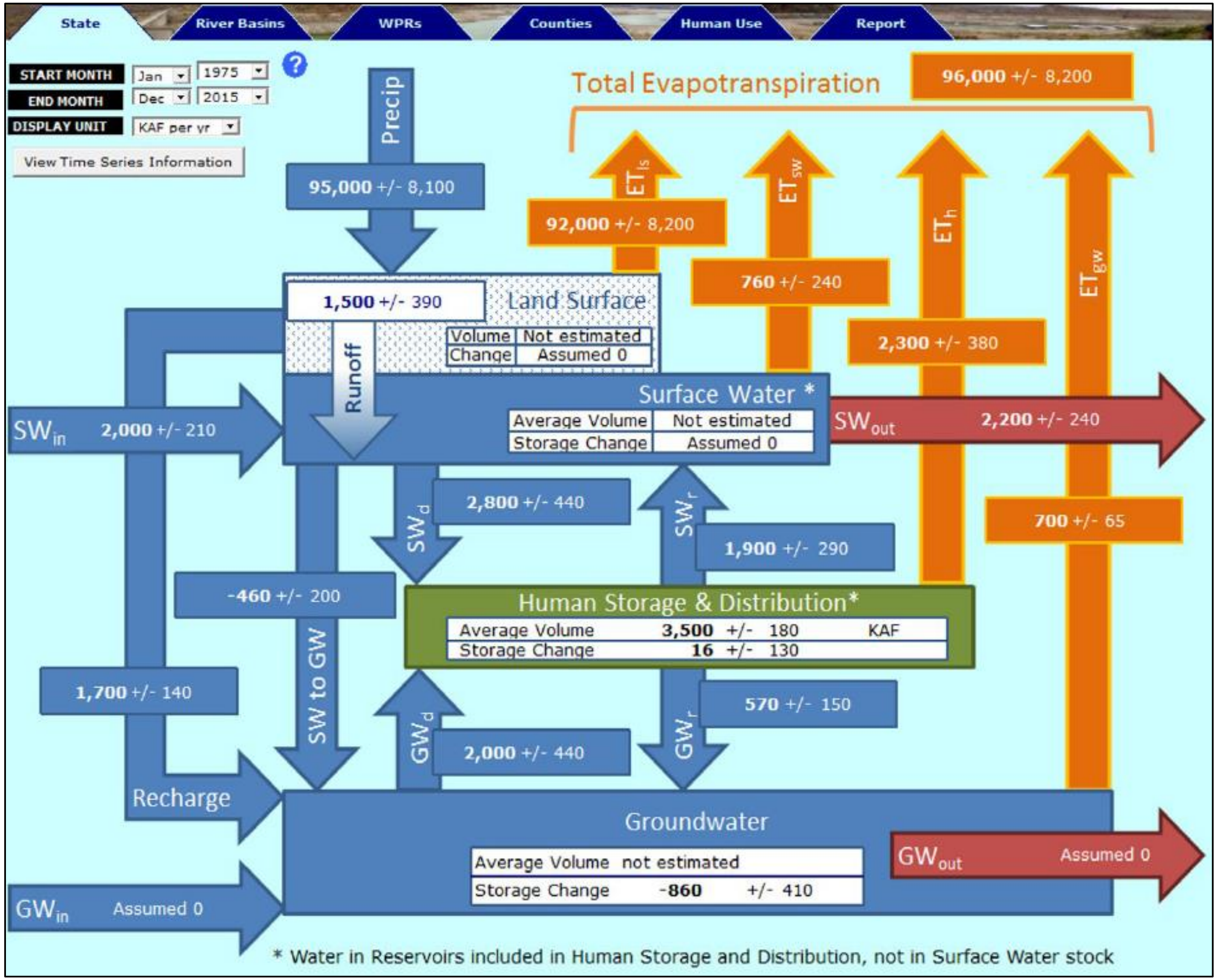
# NM WRRI Overview

Mission: to develop and disseminate knowledge that will assist the state and nation in solving water problems.

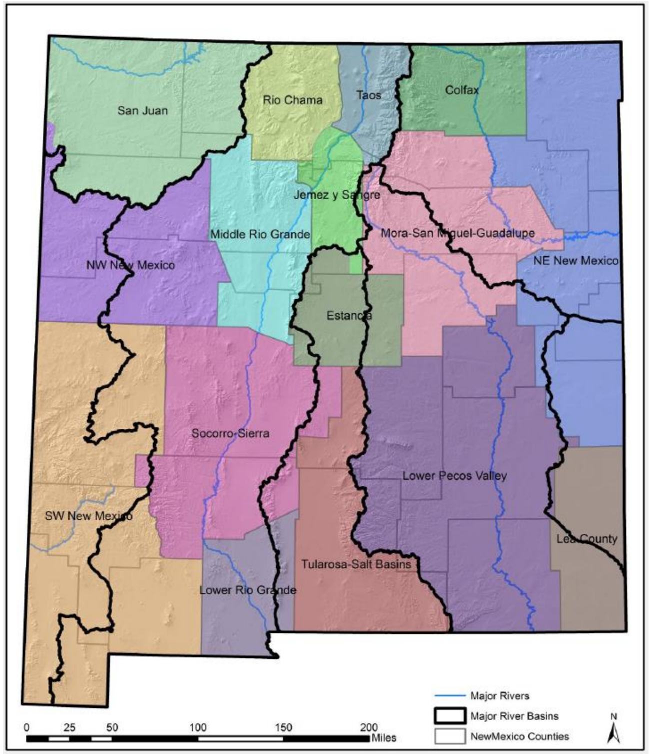
**New Mexico Statute 21-8-40 of 2005:**

- **Provide research and training** in water conservation, planning, and management; atmospheric-surface-groundwater relations; and water quality;
- **Transfer water information** through the use of technical and miscellaneous publications, newsletters, conferences, and presentations;
- **Provide expertise, specialized assistance, and information** to address water problems; and
- **Cooperate** with local, state, and federal water agencies.

# NM Dynamic Statewide Water Budget



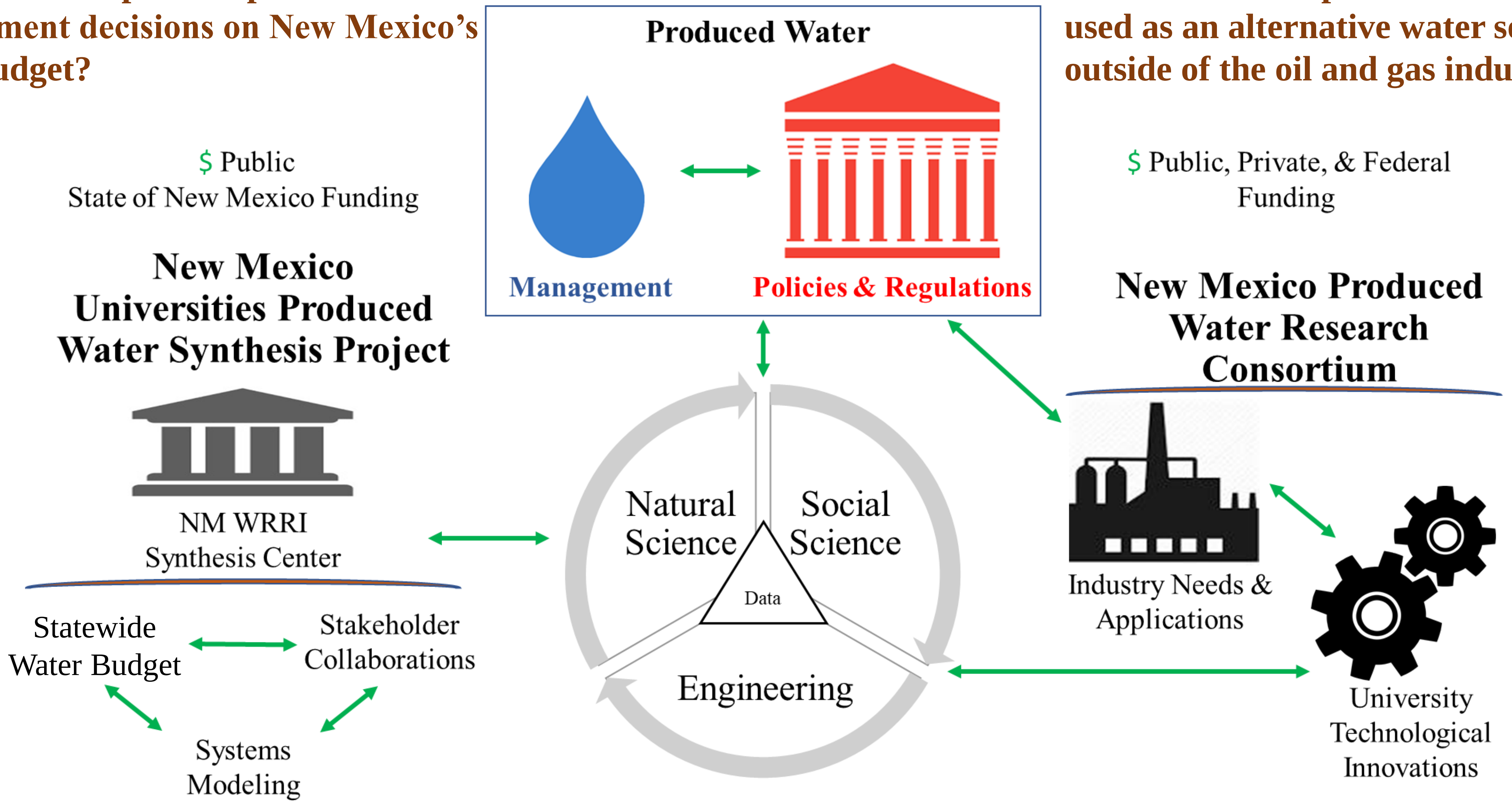

- Stocks & flows
  - Monthly timestep
  - Mass balance
- Historical (1975–2015) & future (2015–2099)
- Counties (33)
- Water Planning Regions (16)
- Major river basins (7)
- Statewide (1)



# Produced Water Research

**What are the impacts of produced water management decisions on New Mexico's water budget?**

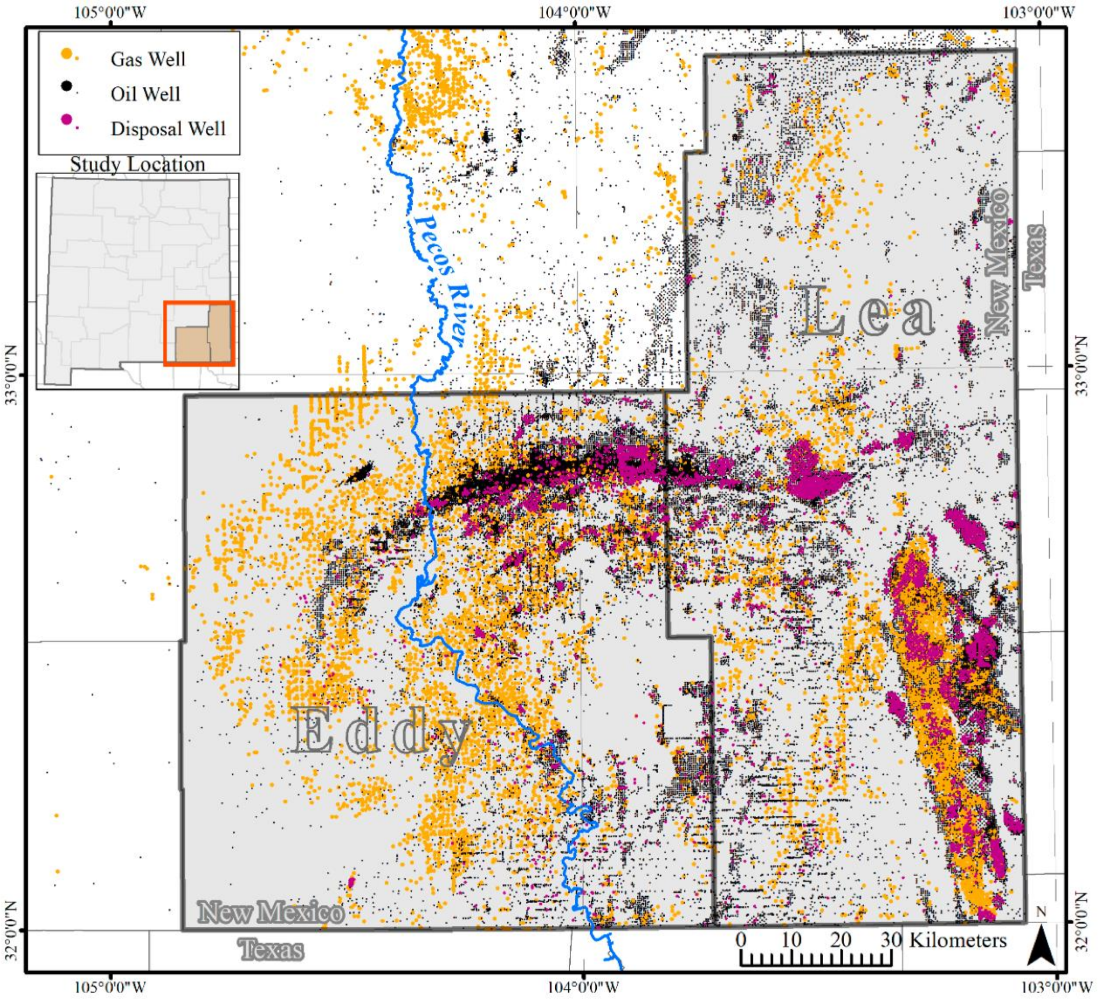
**How can treated produced water be safely used as an alternative water source outside of the oil and gas industry?**



# Studies Published in *Water*:

Sabie, R., Langarudi, S.P., Perez, K., Thomson, B. and Fernald, A., 2022. **Conceptual framework for modeling dynamic complexities in produced water management**. Water, 14(15), p.2341.

Sabie, R.P., Pillsbury, L. and Xu, P., 2022. **Spatiotemporal Analysis of Produced Water Demand for Fit-For-Purpose Reuse—A Permian Basin, New Mexico Case Study**. Water, 14(11), p.1735.



# Conceptual Framework for Modeling Dynamic Complexities in Produced Water Management

Goal:

Provide a conceptual framework to describe the connections of PWM to regional water budgets.

Driving issues:

- Looming shortfalls in water availability
- Oil and gas production generate high volumes of produced water in the region
- Modeling efforts typically do not connect to the regional water budget

Methods:

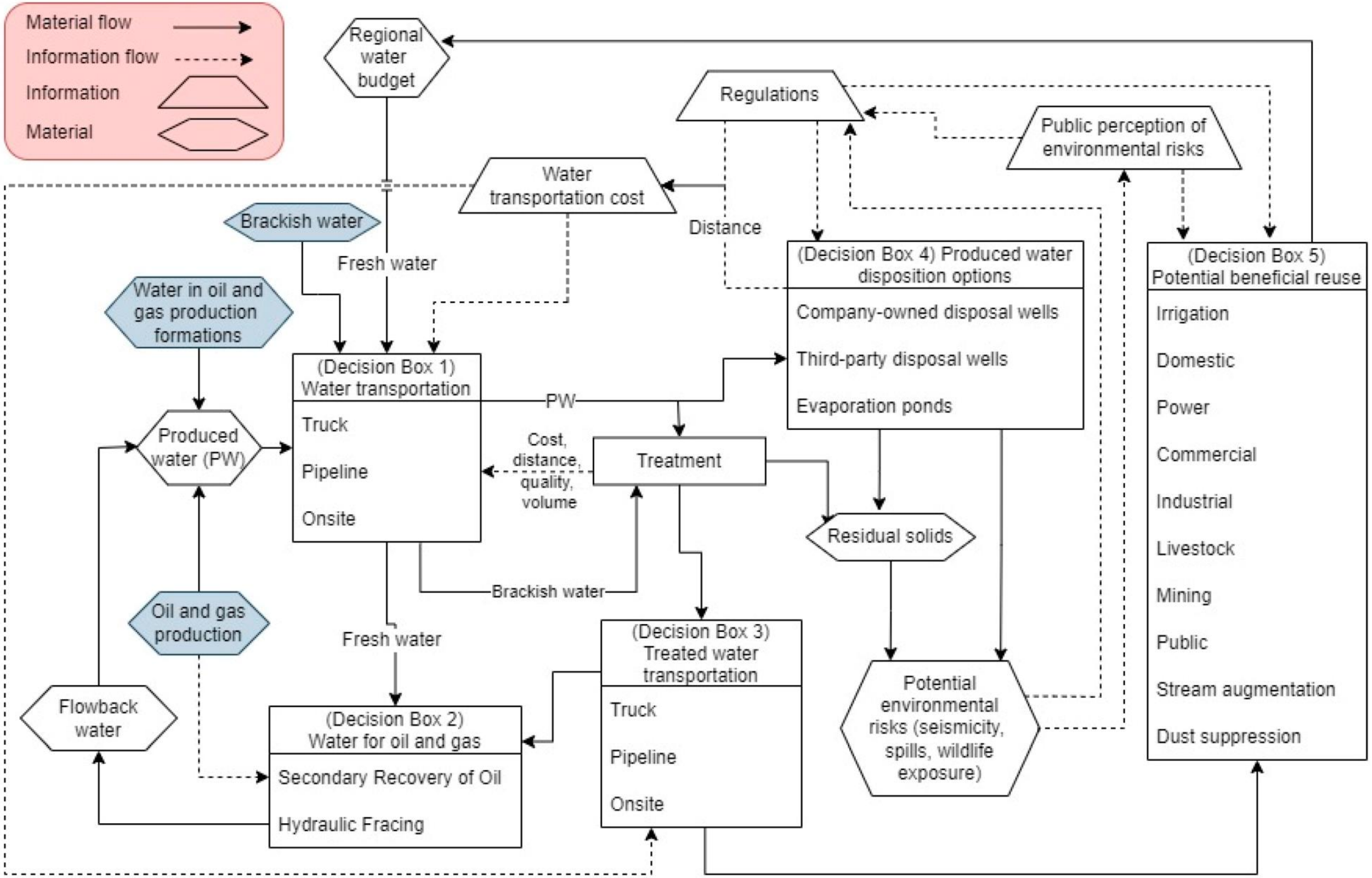
Expert interviews, analysis of industry data, and information gained at industry meetings.

Change in storage = inflows − outflows + source − sinks

$$\Delta S = Q_{in} - Q_{out} + P - ET$$

P = precipitation
$Q_{in}$ = water flow into the watershed
ET = evapotranspiration
$\Delta S$ = change in water storage
$Q_{out}$ = water flow out of the watershed

# Conceptual Framework



# Spatiotemporal Analysis of Produced Water Demand for Fit-For-Purpose Reuse—A Permian Basin, New Mexico Case Study.

Goal: Provide a framework for assessing the spatial and temporal distribution of potential fit-for-purpose demand

Driving issues:

- Looming shortfalls in water availability
- Increase demand for disposal of large volumes of produced water

Assumptions:

- Regulations allow for reuse outside of industry
- No cost barriers for treatment

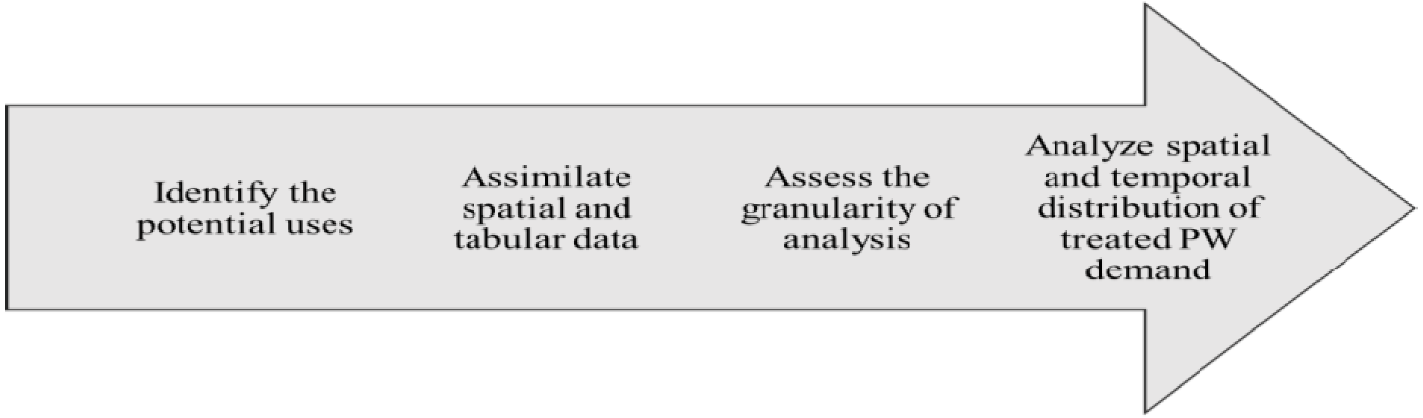
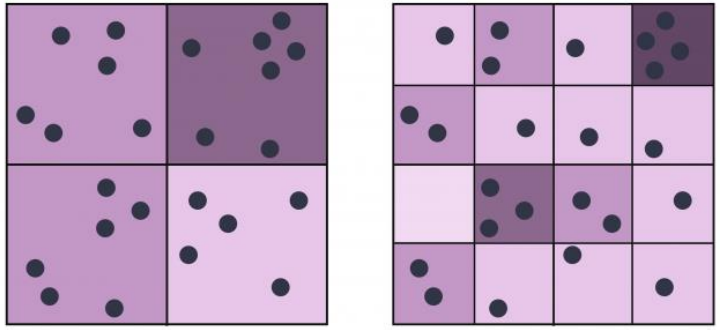



**Figure 1.** General framework for assessing demand of treated PW.

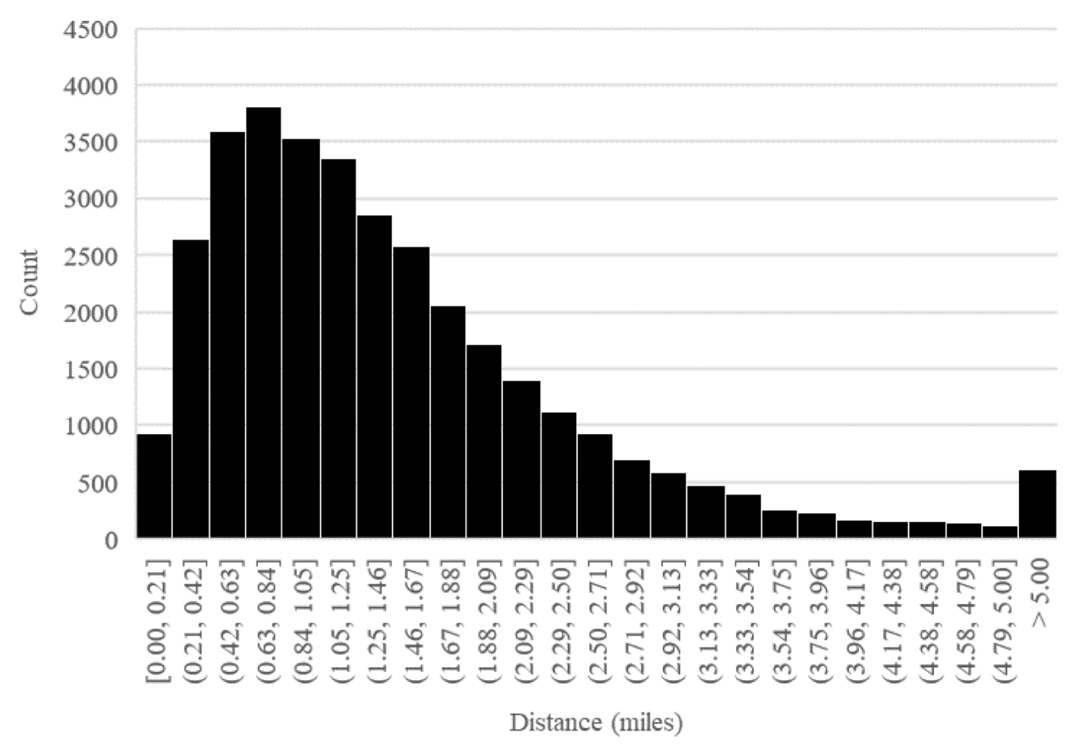
# Determining Grid-cell Size

- Provide detail at a level where any increase in granularity provides little additional unique information for the intended purpose
- Avoid over aggregation and modifiable areal unit problem
- Median distance from oil and gas production wells to SWD in Eddy County was 1.1 miles



https://gisgeography.com/maup-modifiable-areal-unit-problem/

| | Eddy | Lea | Eddy and Lea |
|---|---|---|---|
| Mean | 1.51 | 1.53 | 1.52 |
| Median | 1.10 | 1.34 | 1.21 |
| Mode | 0.51 | 0.83 | 0.51 |
| Range | 16.06 | 8.02 | 16.06 |
| Minimum | 0.00 | 0.01 | 0.00 |
| Maximum | 16.06 | 8.02 | 16.06 |
| Count | 17299 | 17211 | 34510 |



# Estimated Available Produced Water Volume (per grid cell)

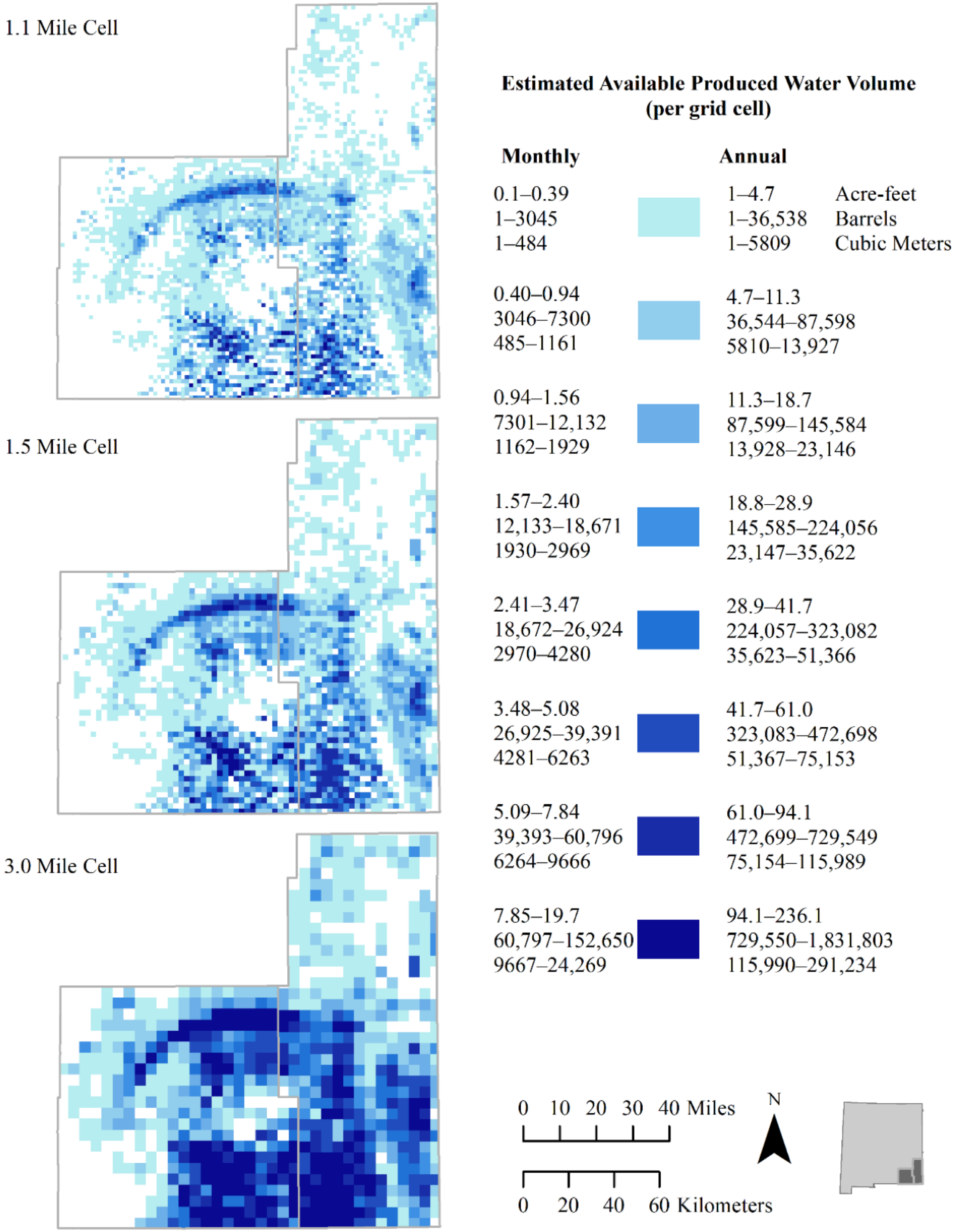
- Count active vertical and horizontal wells in grid cell
- Multiply by average PW vol/yr
- Multiply by 0.42 to account for the estimated amount currently being reused within industry
- Multiply by 0.5 to account for a 50% recovery rate

- Eddy County: 22,855,016 m3 (18,536 acre-feet)
- Lea County: 22,605,859 m3 (18,334 acre-feet)

**Table 1.** Average annual PW volume per well for oil and gas wells in southeastern New Mexico in 2019.

| | Wells | Horizontal Well Avg. PW/yr ($m^3$) | Vertical Well Avg. PW/yr ($m^3$) |
|---|---|---|---|
| Oil | 21907 | 19560 | 3340 |
| Gas | 2850 | 48330 | 2540 |

Data from Jiang et al. [21].



# Agricultural Water Demand

Estimated
Eddy :170,944 acre-feet
Lea: 343,915 acre-feet

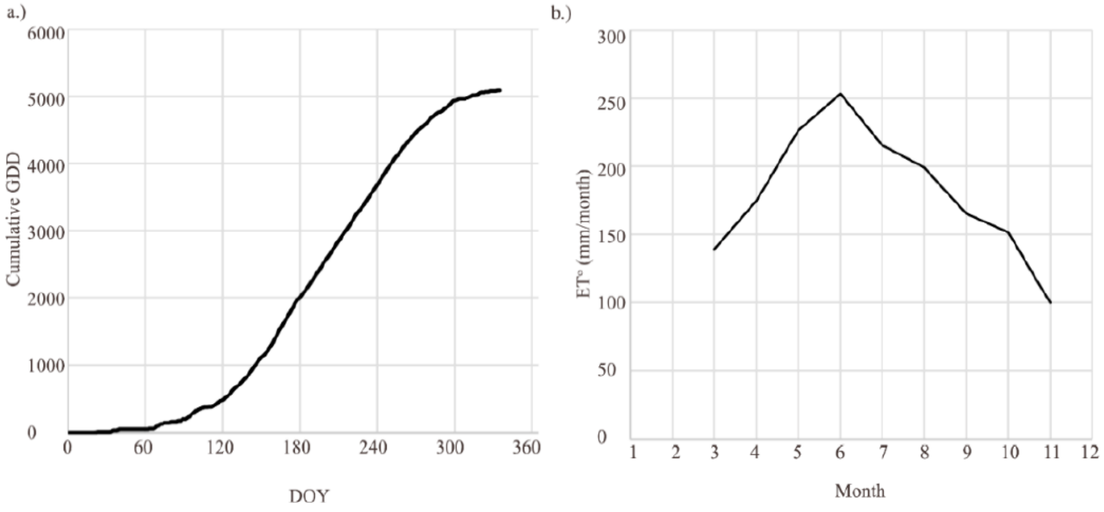
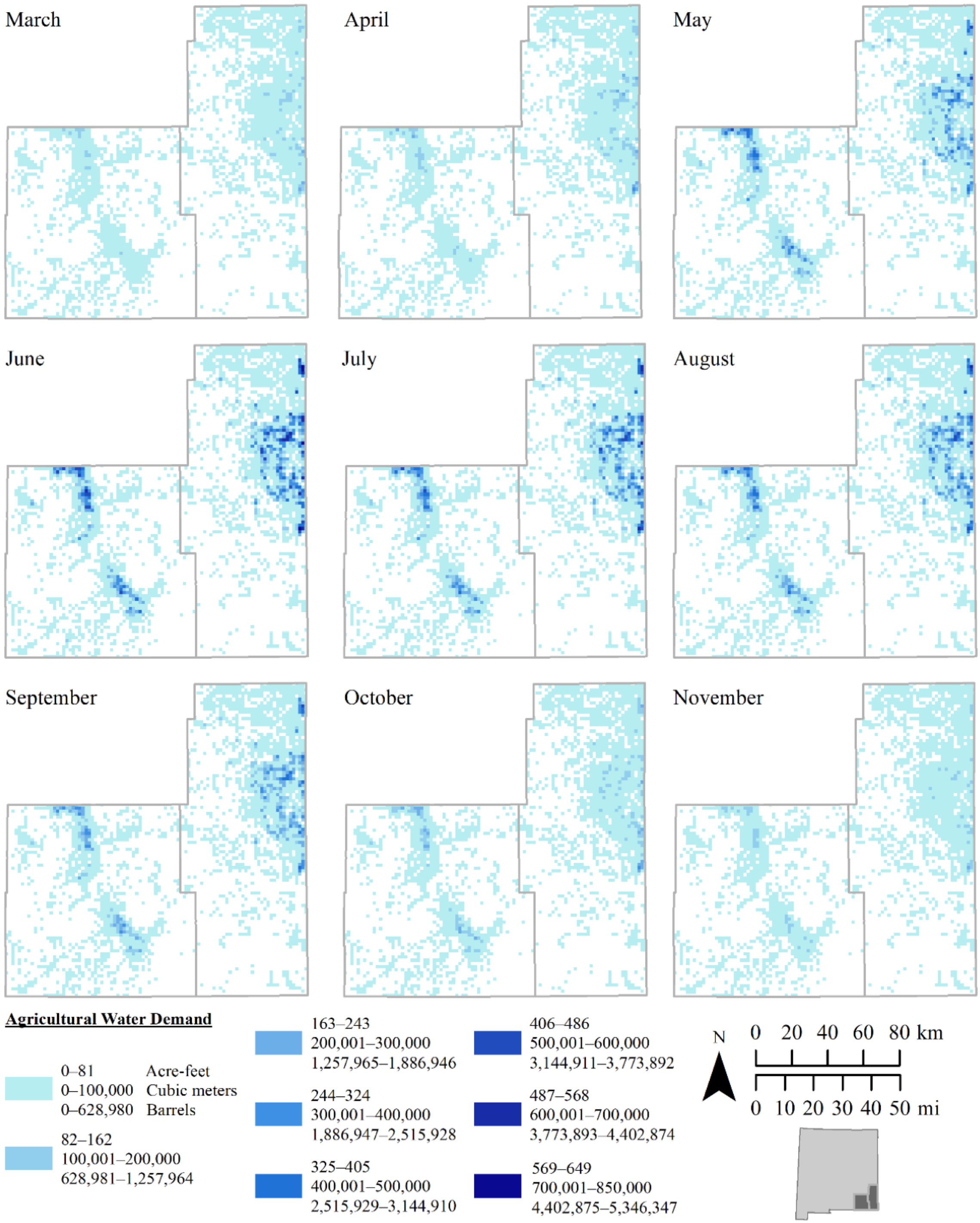



**Figure 3**. a) Cumulative growing degree days (GDD) at base 50, and b) reference evapotranspiration 294 in for the Artesia Agricultural Science Center in 2021.



# Hypothetical – Dust Suppression Use of Treated Produced Water

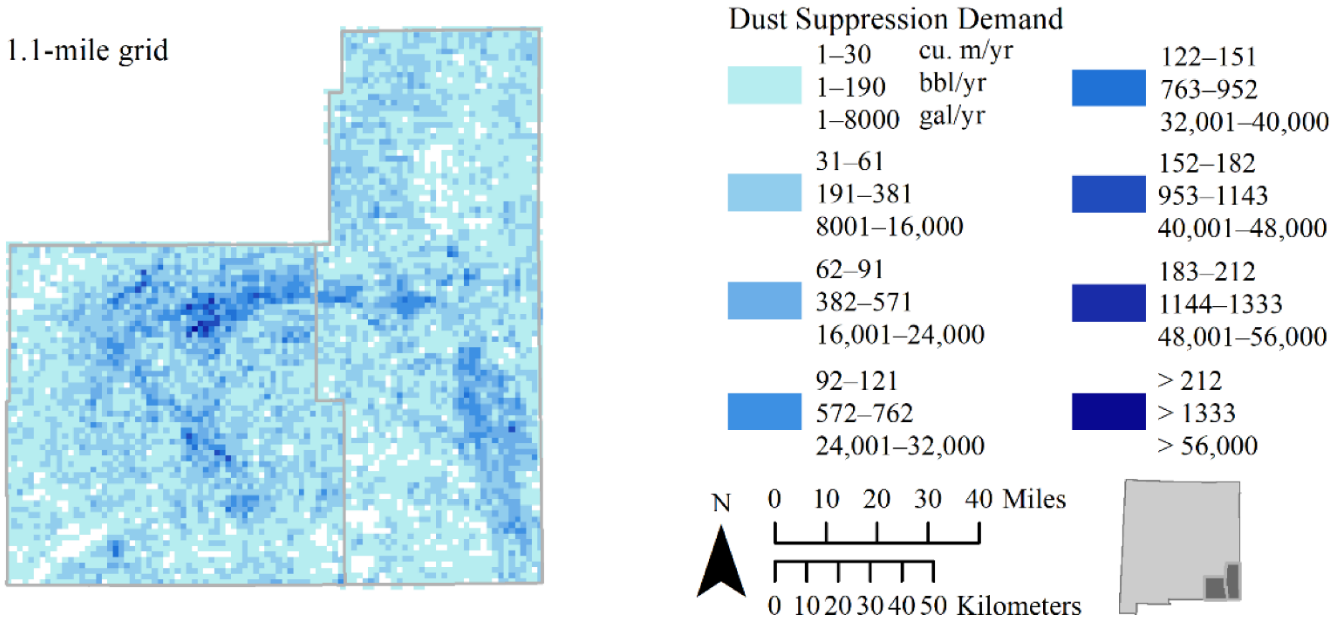
Estimated unpaved roads

Eddy: 9,884 miles

Lea: 8,776

Assumed application rate of 3,388 gallons/mile

33,488,465 gallons/year or 797,344 bbls/year



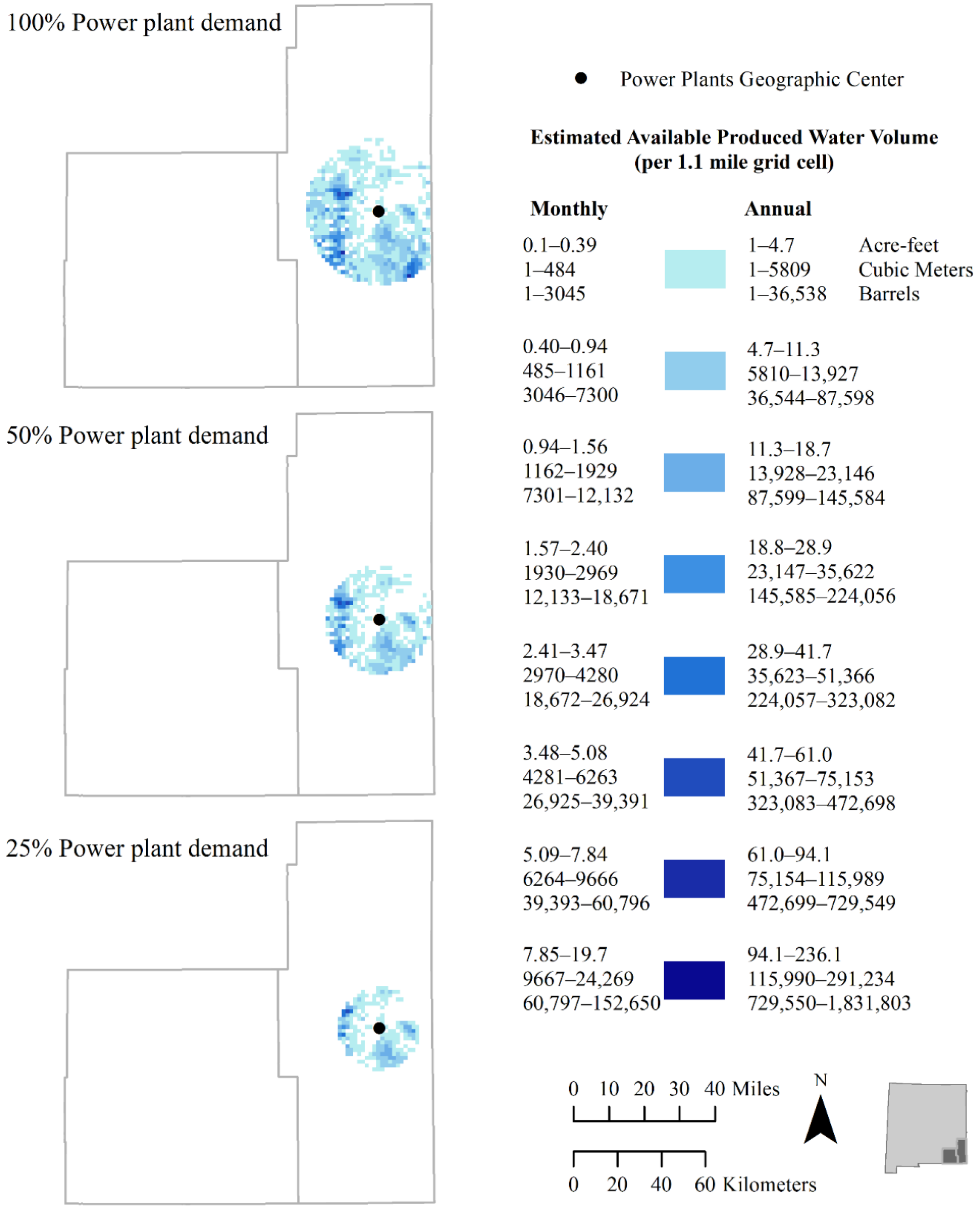

Estimated water demand for dust suppression based on the length of unpaved roads within each grid cell.

# Hypothetical – Power Plant Use of Treated Produced Water

Assumed demand: 4,472 acft

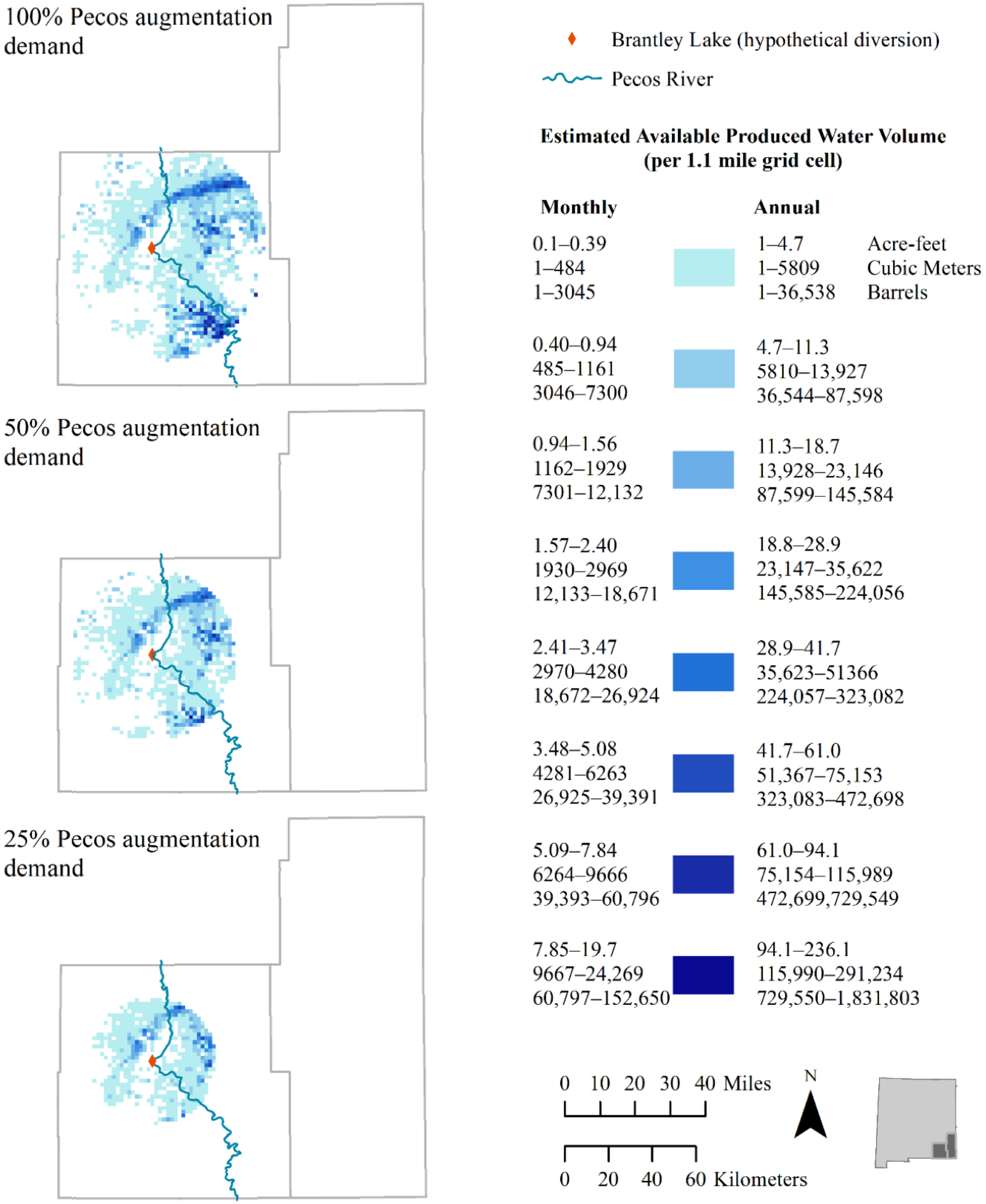
Area of collection required based on estimated supply to meet 100%, 50%, and 25% of the water demand for power plant demand in Lea County.

Collection area was 821 $mi^2$,455 $mi^2$, and 252 $mi^2$, respectively



# Hypothetical- Pecos River Augmentation with Treated Produced Water

- Assumed an augmentation demand of 10,000 acft (77.5 million bbl)
- Area of collection required based on estimated supply to meet 100%, 50%, and 25% of the water demand for Pecos River augmentation.
- Collection area was 1,488 623 mi$^2$, 1,048 mi$^2$, and 667 mi$^2$, respectively
- Many of the grid cells generate less than 2 acre-feet of produced water per year



# Next steps

1. Use conceptual modeling framework to construct a modeling component that connects produced water management decisions.
2. Incorporate pipelines/distribution network into spatial model.

# Thank you!

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Special thanks to the researchers of the NM Universities Produced Water Synthesis Project