

Produced water brine and stream salinity

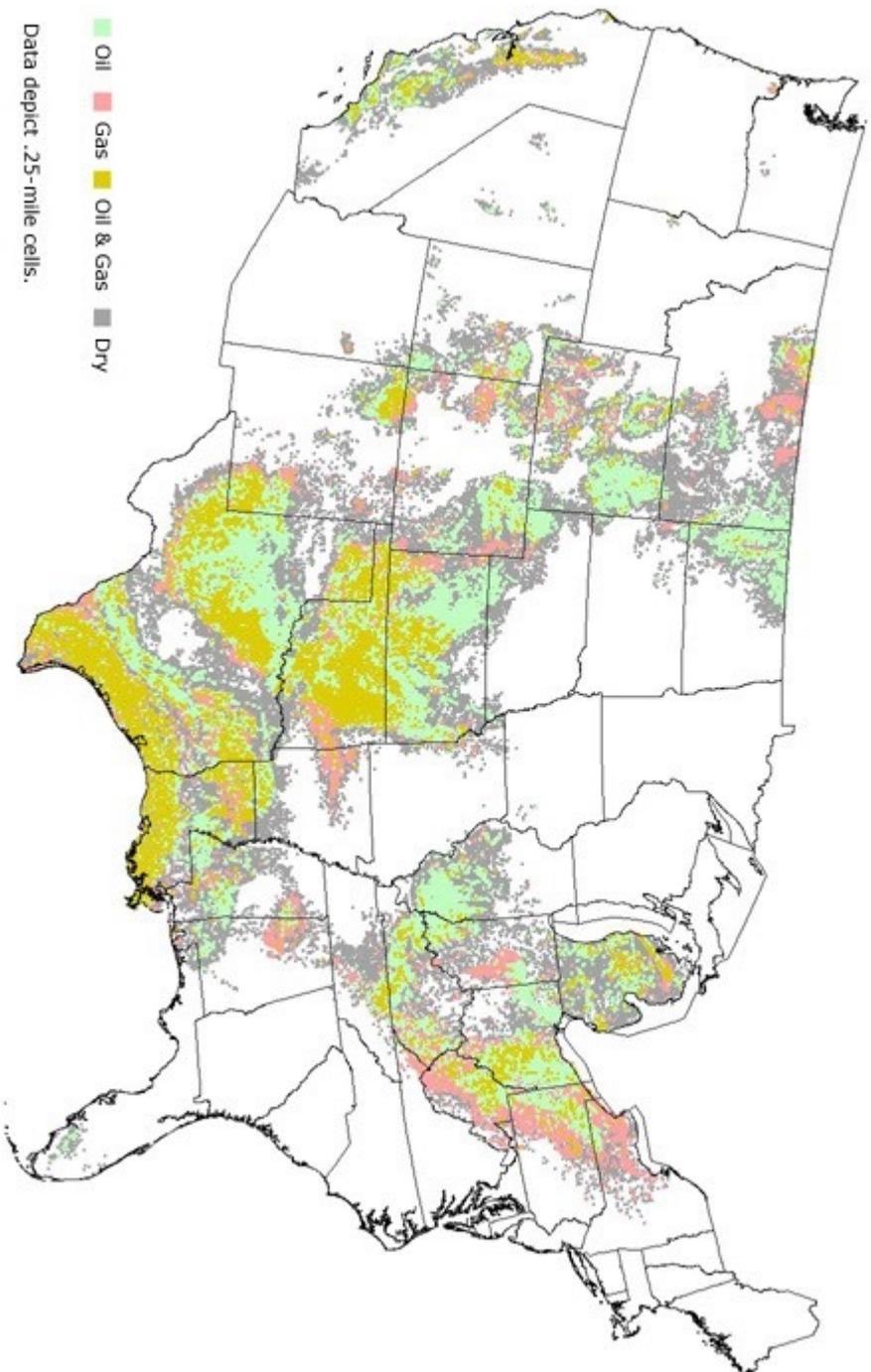
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Tracey Mercier

The problem

- There are approximately 3.8 million oil and gas wells in the lower 48 states.
- Production of oil and gas has occurred for over 100 years.

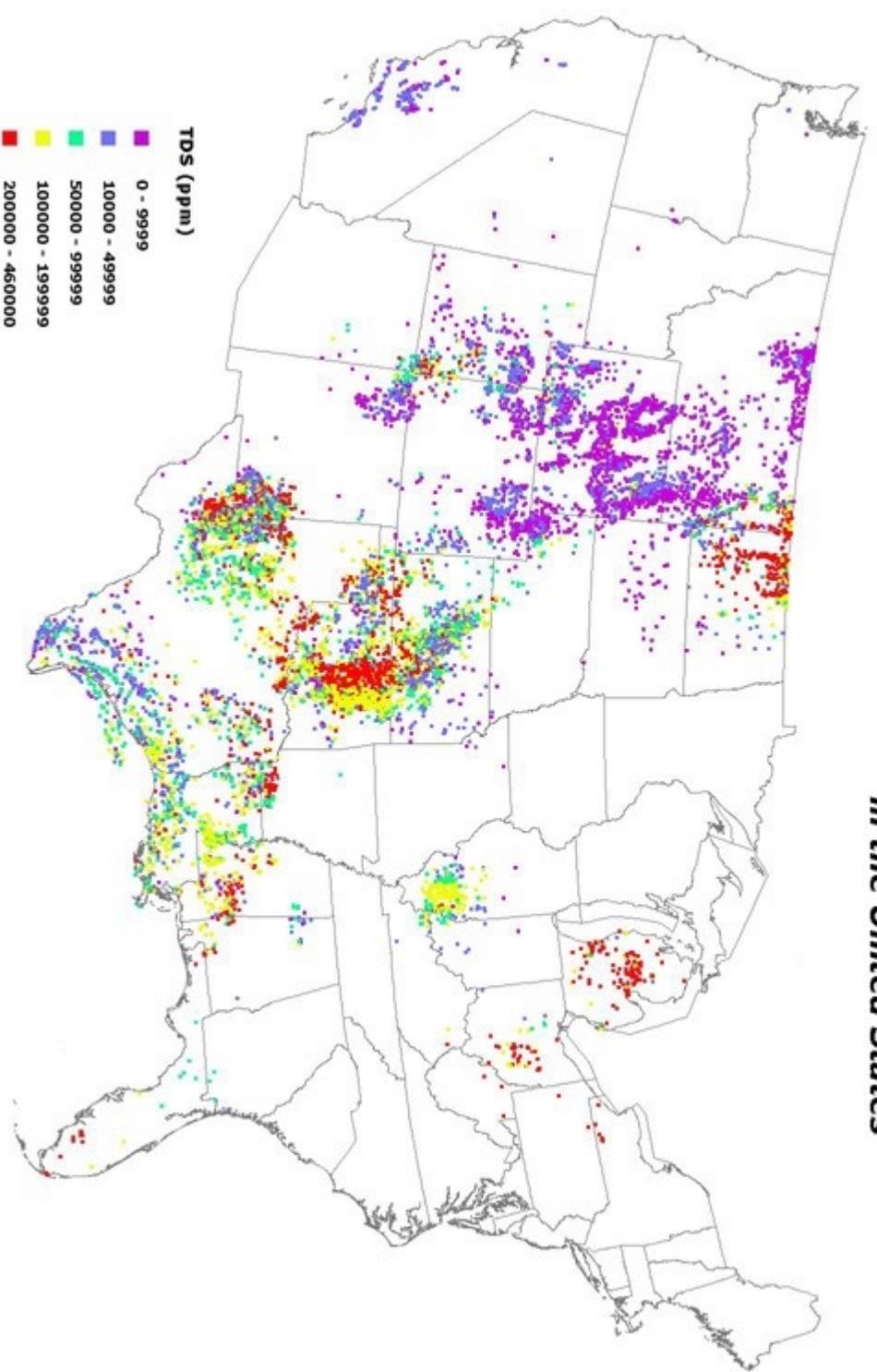
Distribution of Oil & Gas Wells



The problem

- 20 to 30 billion barrels of produced water are generated by oil and gas production operations each year. This is 70 times the volume of all liquid hazardous wastes generated in the U.S.
- This water ranges in salinity from a few thousand to 463,000 ppm TDS.

Chemistry of Produced Waters in the United States



The problem

Presently, 95% of all produced waters are reinjected, however prior to modern environmental regs (1965-70), a high percentage of produced waters were released to the surface.

Brine disposal in nine counties, Colorado River watershed, Texas (1000s of bbls)

<u>Year</u>	<u>Surface</u>	<u>Subsurface*</u>	<u>Total</u>
1957	19,849	30,068	49,917
1961	10,798	55,475	66,273
1967	1,191	67,606	68,797
1983	0	376,810	376,810

*- The majority of this represents waterflooding.

The problem

- In spite of modern environmental regs, many small- to moderate-sized operators continue to release substantial quantities of produced water to the surface and shallow subsurface because of leaky tanks, pumps, and flowlines, accidents, vandalism, equipment failure, and the continued use of pits as part of production operations rather than as emergency backup.



DEC 4 2001

The problem

- Injection wells are subject to periodic failures of various types resulting in releases:
 - Pump breakdown
 - Corrosion of the well bore
- UIC program of EPA and States monitors wells used for injection. These are the Class II wells.

The problem

- Thus oil and gas production areas in the U.S. typically have a legacy of soil and ground water contamination which continues to provide salts and other contaminants to ground and surface waters.
- They also have ongoing contributions of saline water from present operations.

The problem

- With aging infrastructure in most producing areas and the continual sale of production to smaller and smaller operators, the potential for increase in releases is present.

Summary

- High volumes of water
- Substantial historical and ongoing releases
- High TDS, especially Na and Cl
- Other attributes
 - Corrosive and oxygen-free waters
 - High trace element content
 - Dissolved organic constituents

Present work

- The GD Energy Program is conducting investigations of the impacts of produced water releases at varying scales from individual sites, to a small watershed, to a regional and national watershed and aquifer evaluation.
- The WRD Toxic Substances Hydrology Program is collaborating on the site investigations.

Approach for national overview

- Develop a simple model of “watershed susceptibility” using a simple algorithm and available Energy Program and other datasets and GIS coverages.
- Test against available water quality datasets.
- Modify model to add complexity and explanatory capabilities.

Simple algorithm- parameters

- Density of oil wells in a watershed
- Average produced water salinity (TDS)
- Rainfall (a dilutant)

$$WS = \frac{WD + S}{P}$$

P where:

WS= watershed susceptibility

WD= well density factor

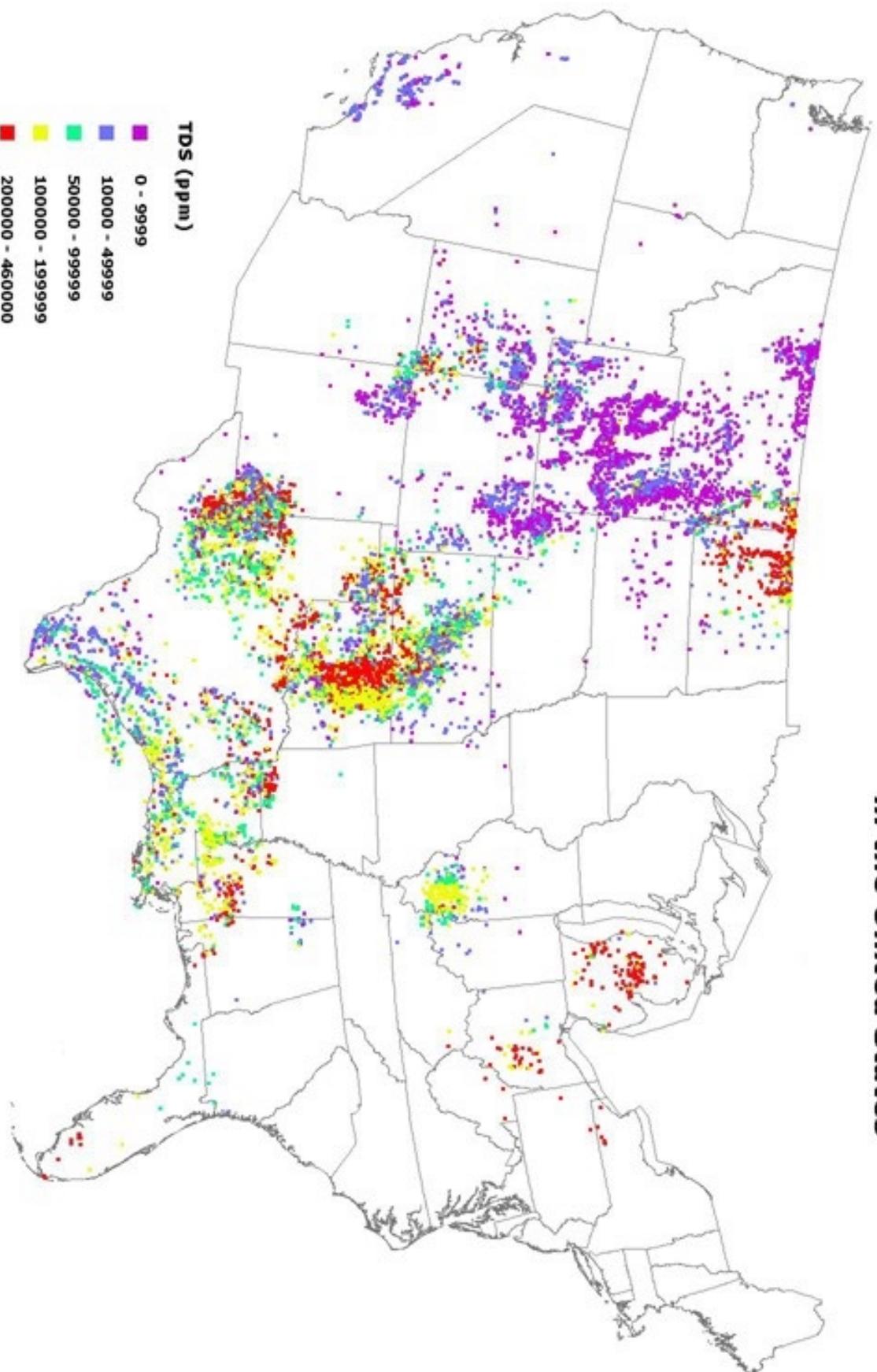
S= average salinity factor

P= average precipitation factor

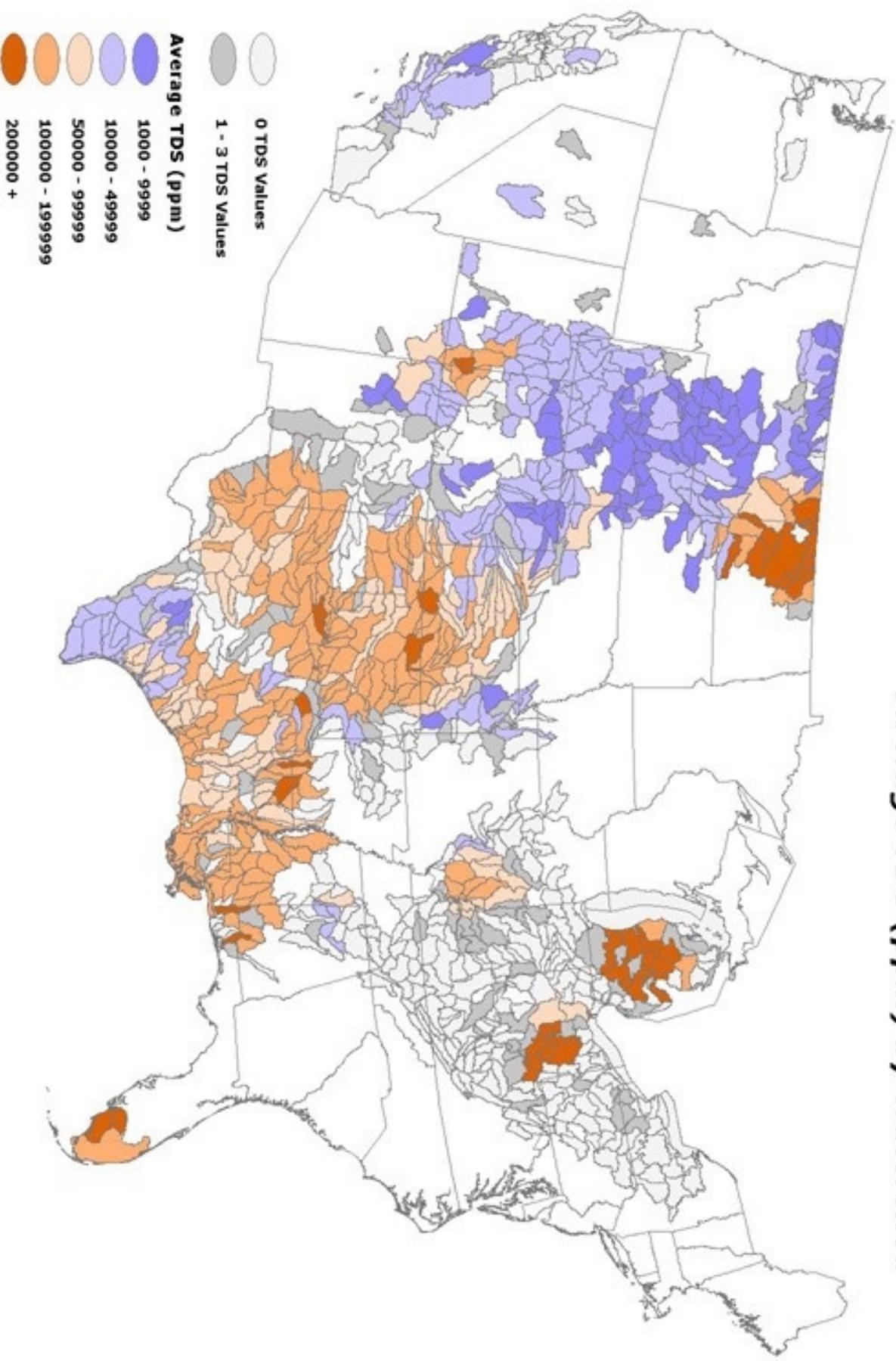
Datasets for simple model

- Watershed maps (HUC 8-digit)
- Distribution of oil wells in the U.S. (gas wells dropped from consideration)
- Produced water chemistry
- Precipitation (by watershed)

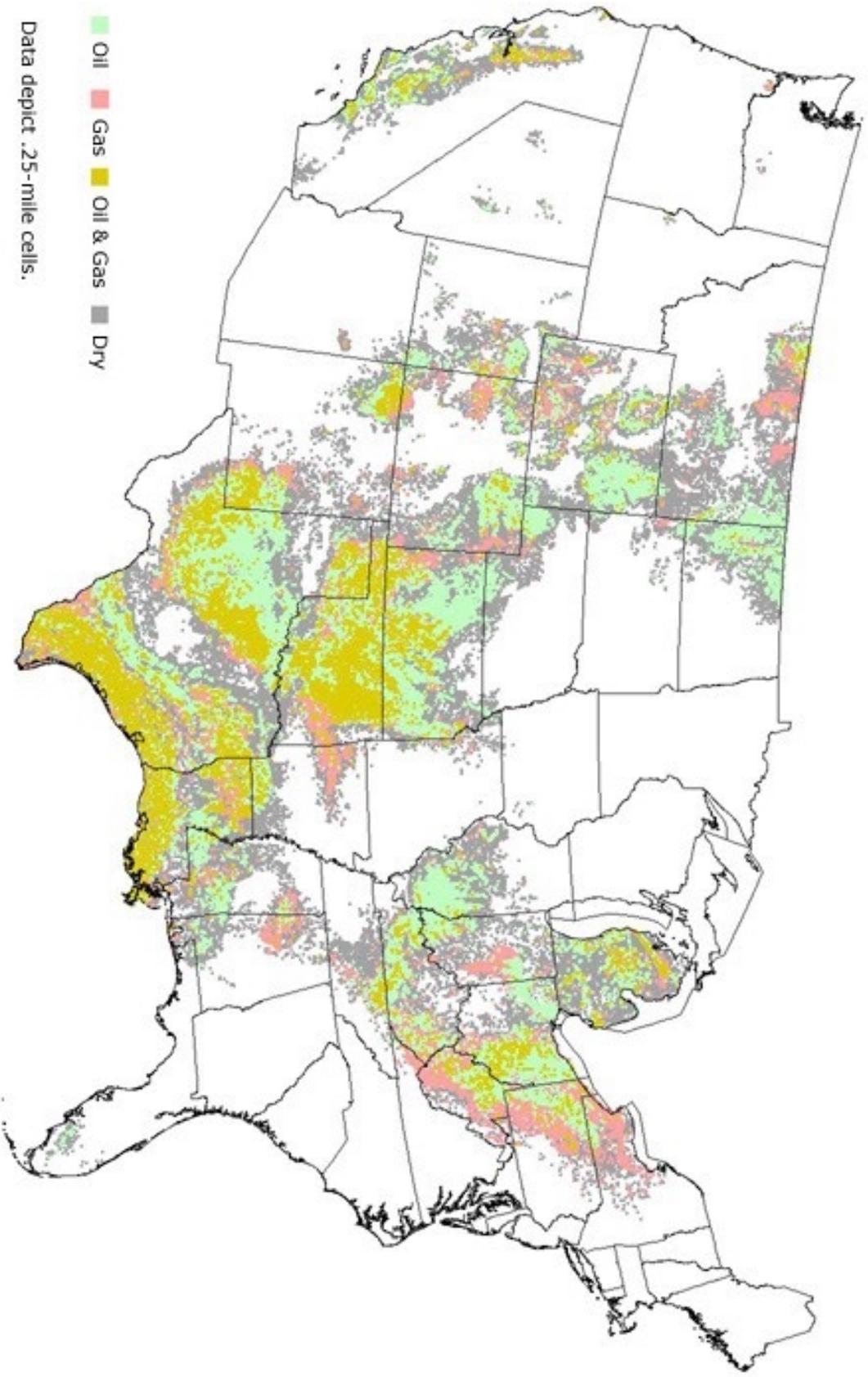
Chemistry of Produced Waters in the United States



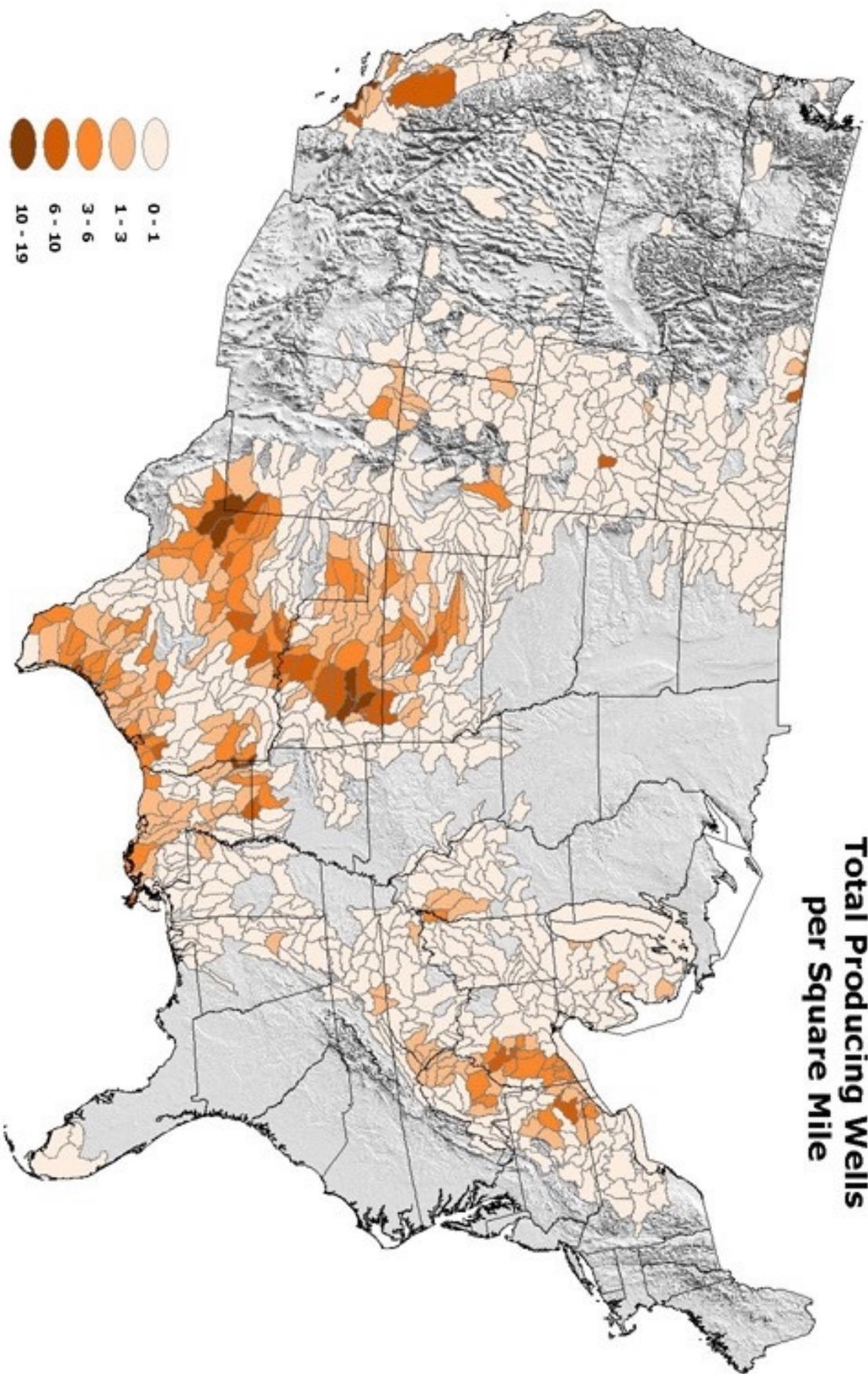
Average TDS (ppm) by Watershed

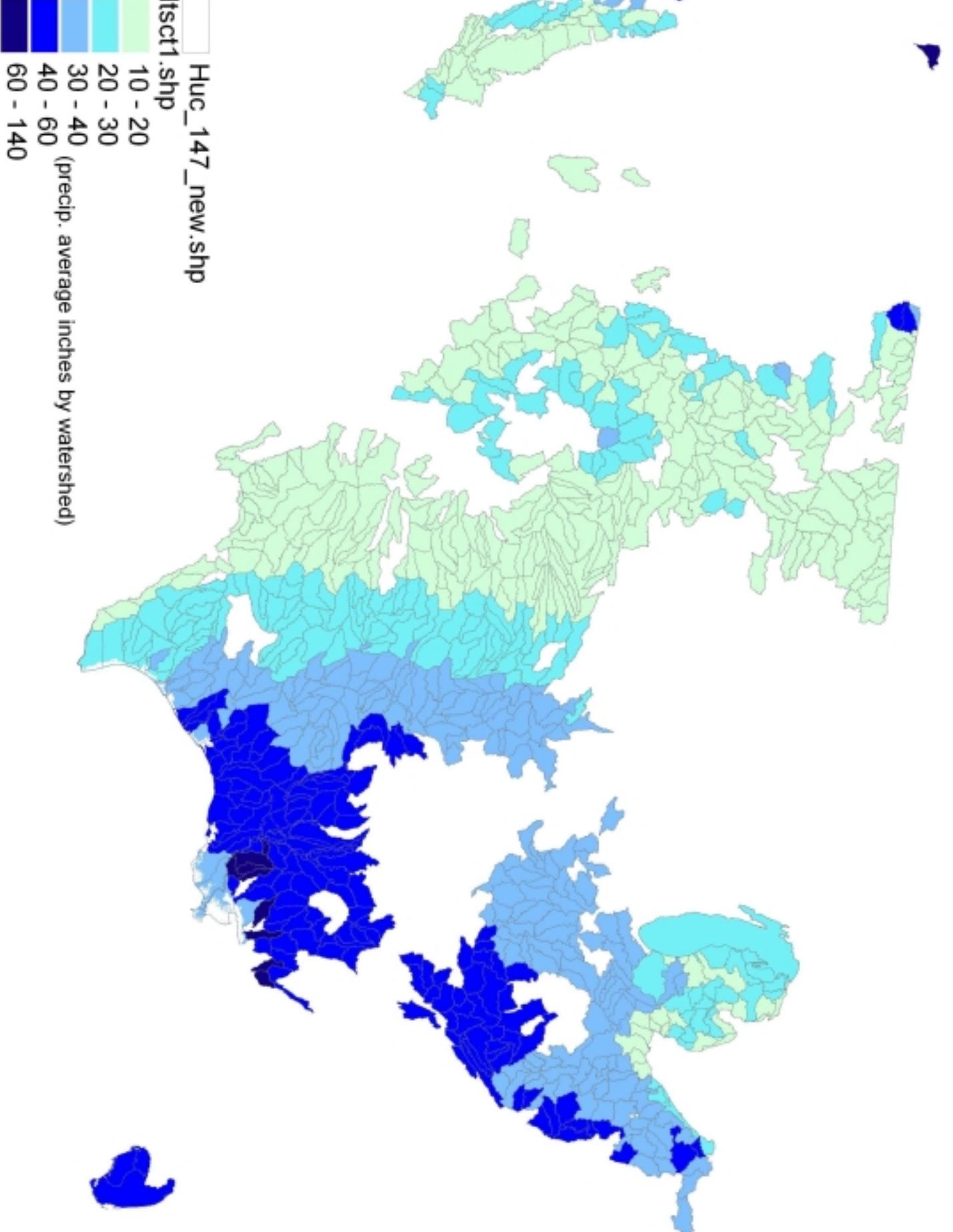


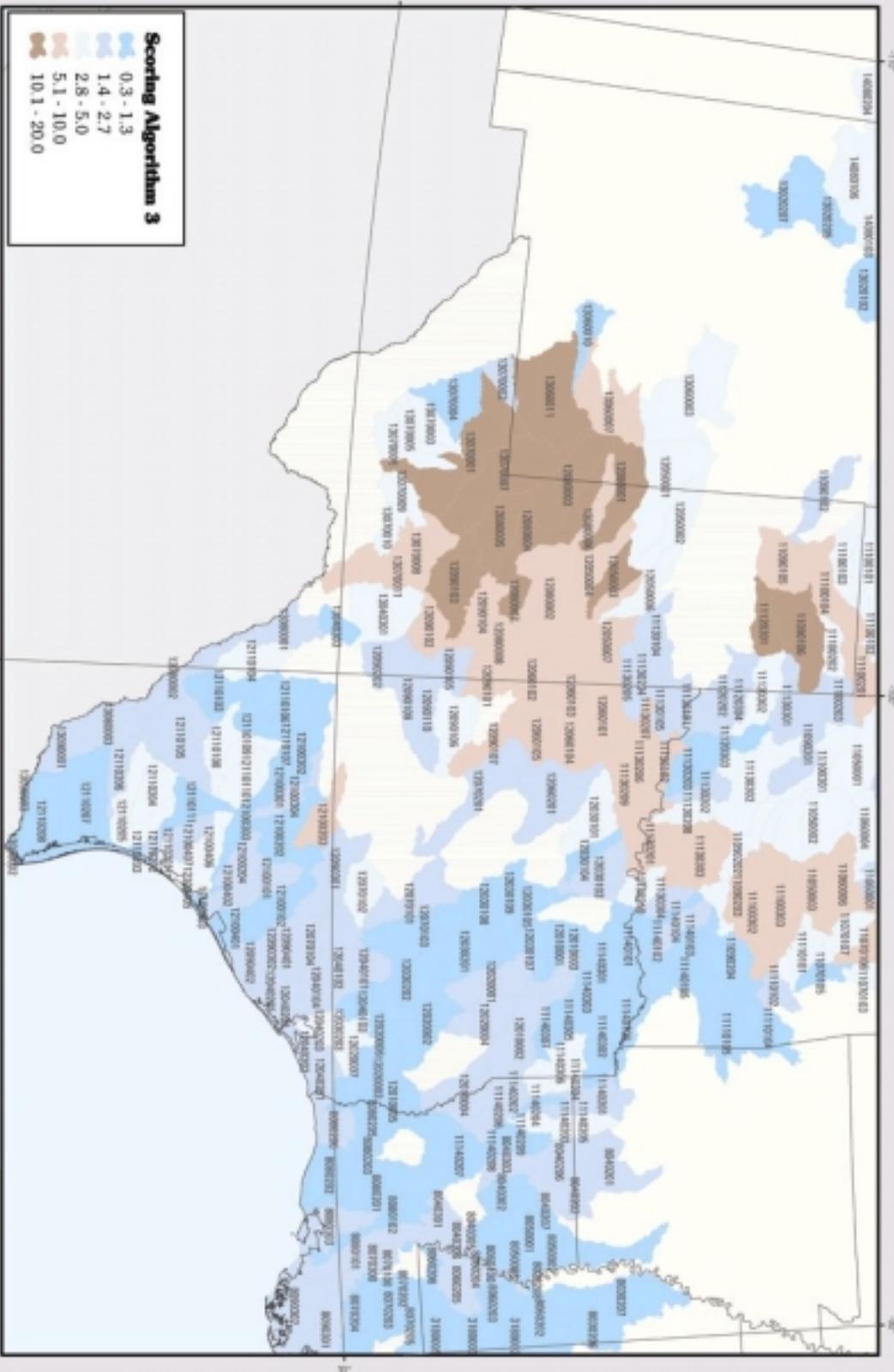
Distribution of Oil & Gas Wells



**Total Producing Wells
per Square Mile**







Scoring Algorithm 3

- 0.3 - 1.3
- 1.4 - 2.7
- 2.8 - 5.0
- 5.1 - 10.0
- 10.1 - 20.0

Scale 1 : 8 000 000

0 100 200 400 Miles
0 100 200 400 Kilometers

Watershed Susceptibility Study

DRAFT

Prepared by James Otton
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November 2001

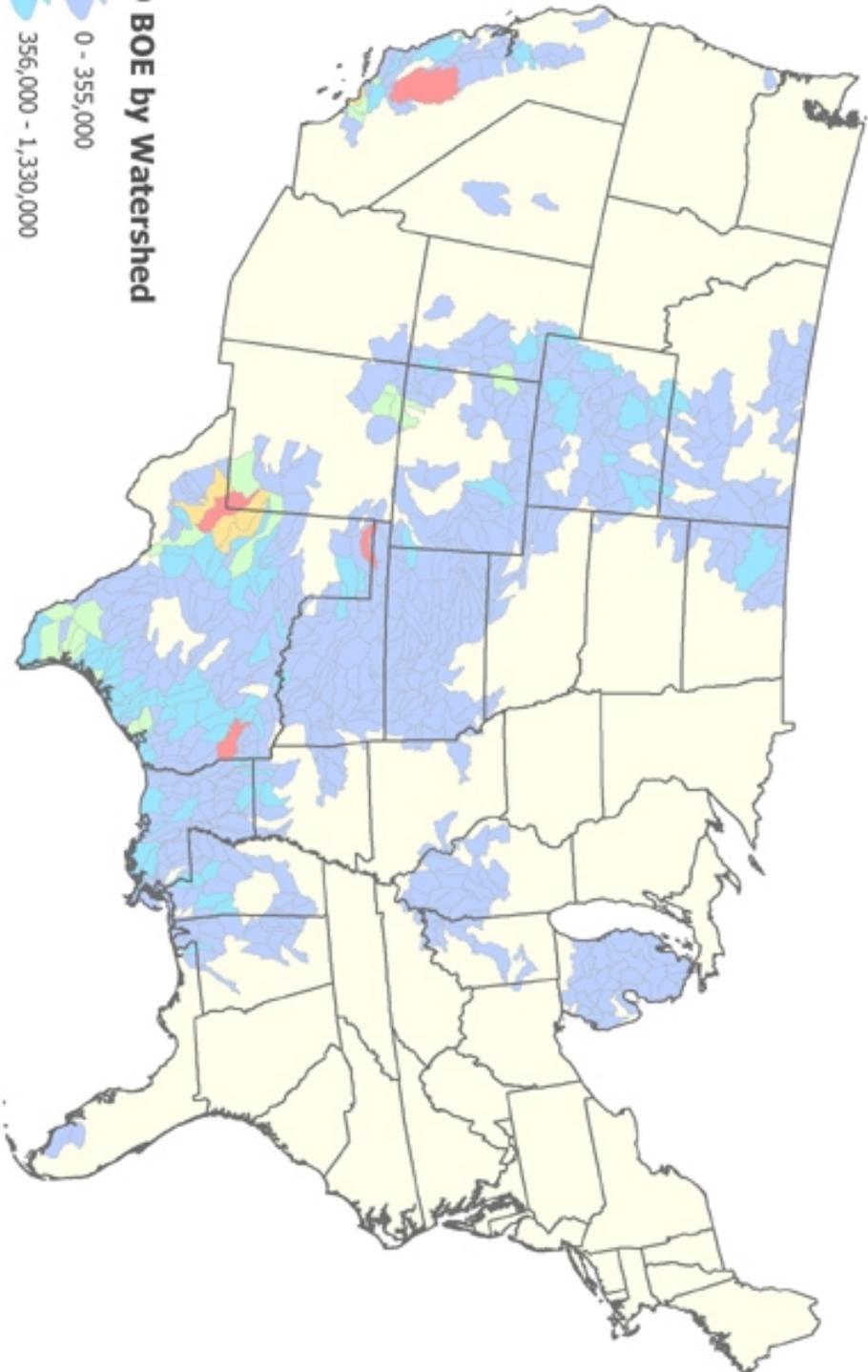
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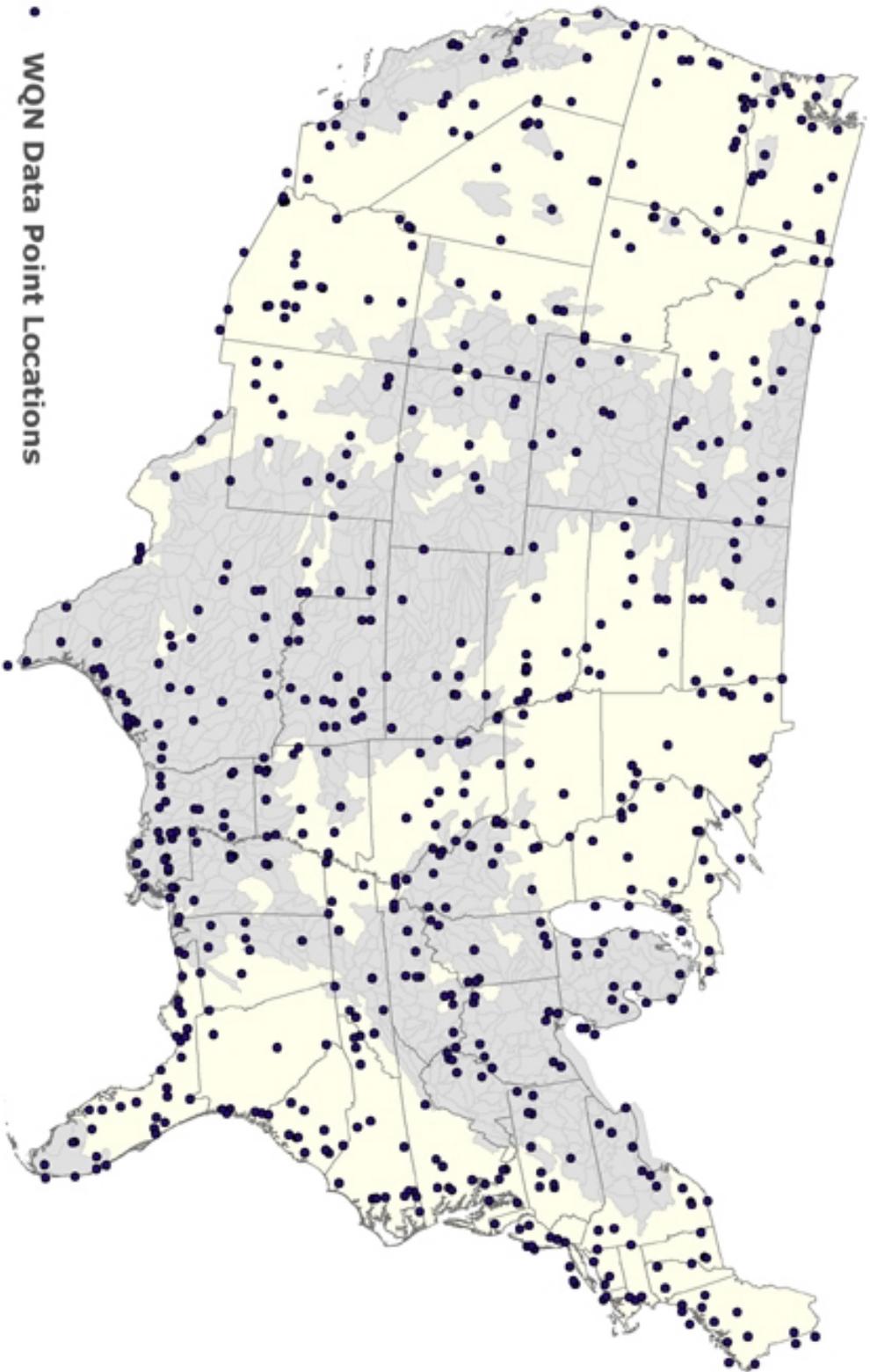
USGS
science for a changing world

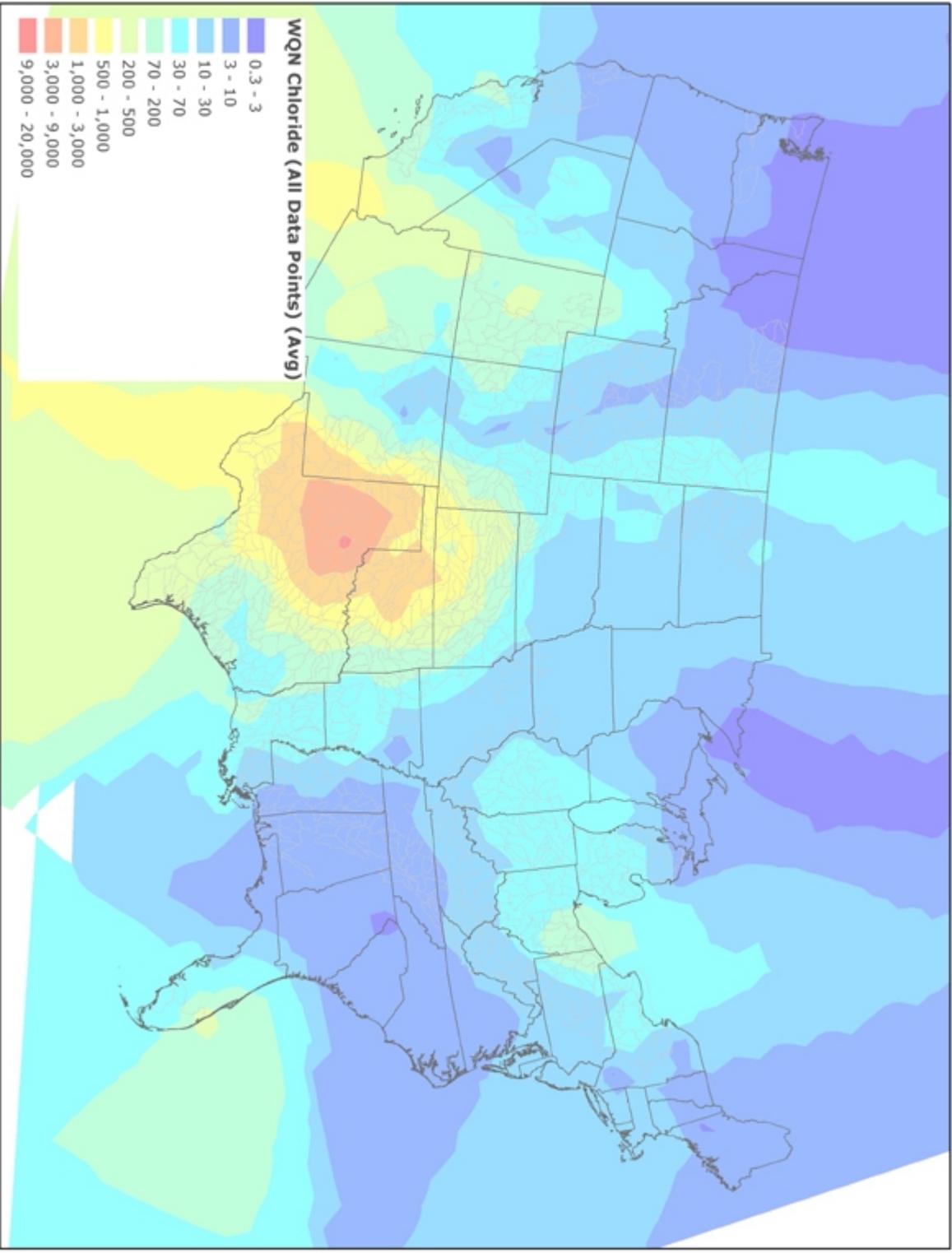
Other data to consider?

- Produced water volumes
 - no national database, more difficult to get than PW chem
- Production as a surrogate?

1999 BOE by Watershed





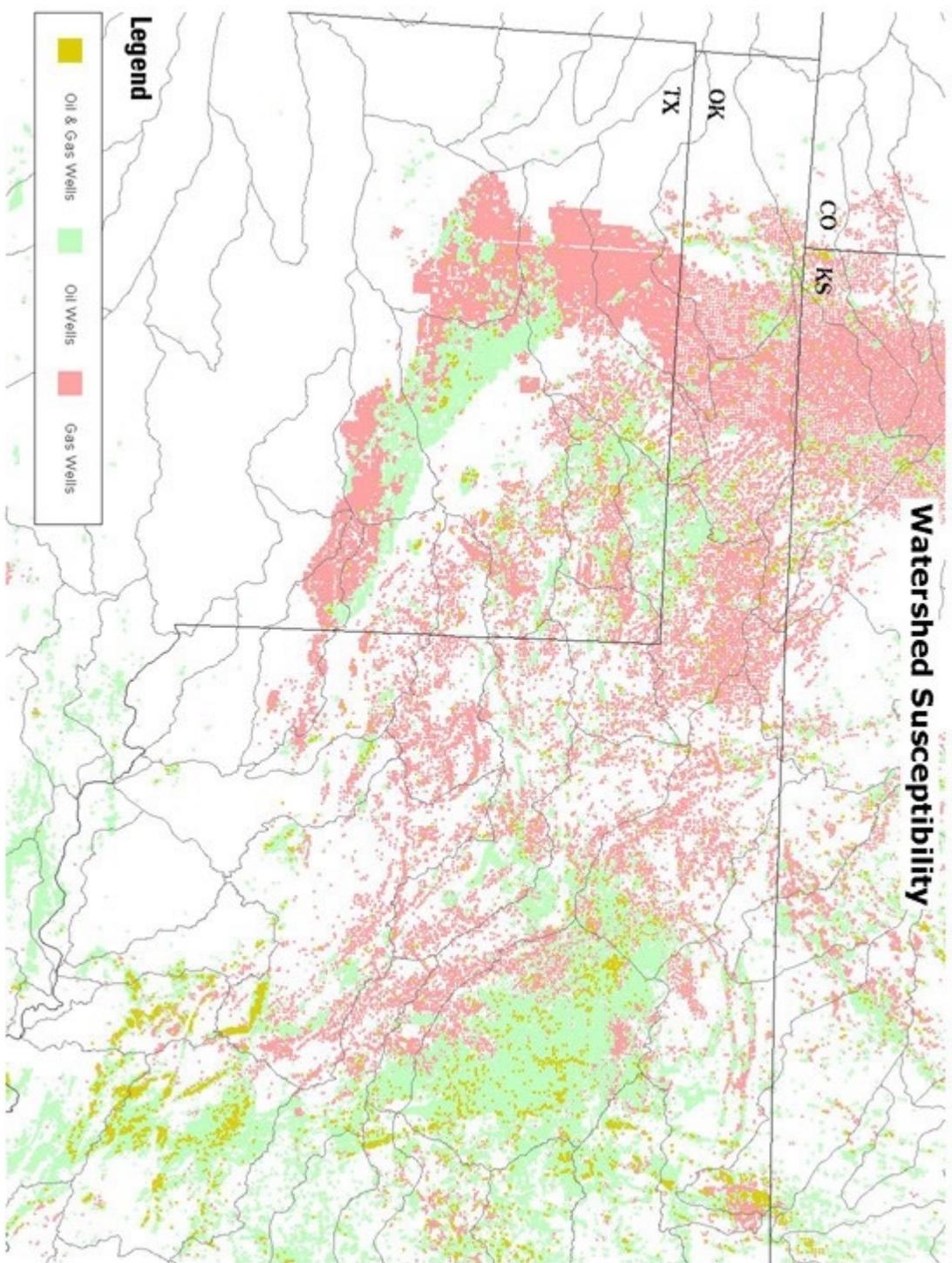


Salinity in Southern High Plains

- Salt-bearing bedrock sources
- Agriculture and human wastes
- Produced water brines

- The Energy program is interested in working with SPARROW to develop models describing salinity in the U.S.

Watershed Susceptibility



Legend

- Oil & Gas Wells
- Oil Wells
- Gas Wells

Average Annual Runoff in Inches

