



ELECTRIC POWER
RESEARCH INSTITUTE

Electric Power/Water Sustainability

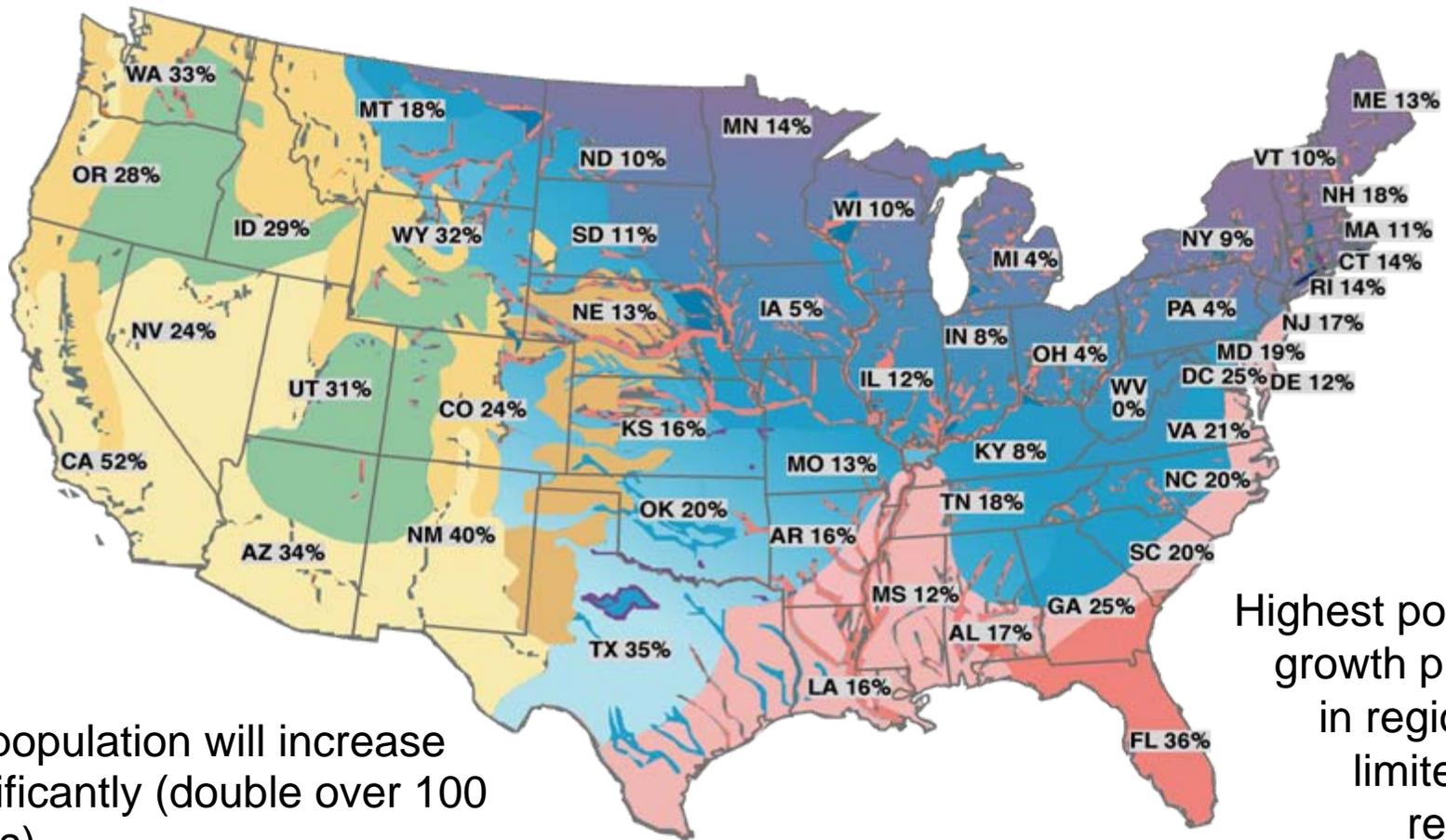
Robert Goldstein, rogoldst@epri.com

Energy-Water Nexus, Central Regional
Workshop

Kansas City, MO

November 15, 2005

Water Resources and Population Growth, 2000-2020



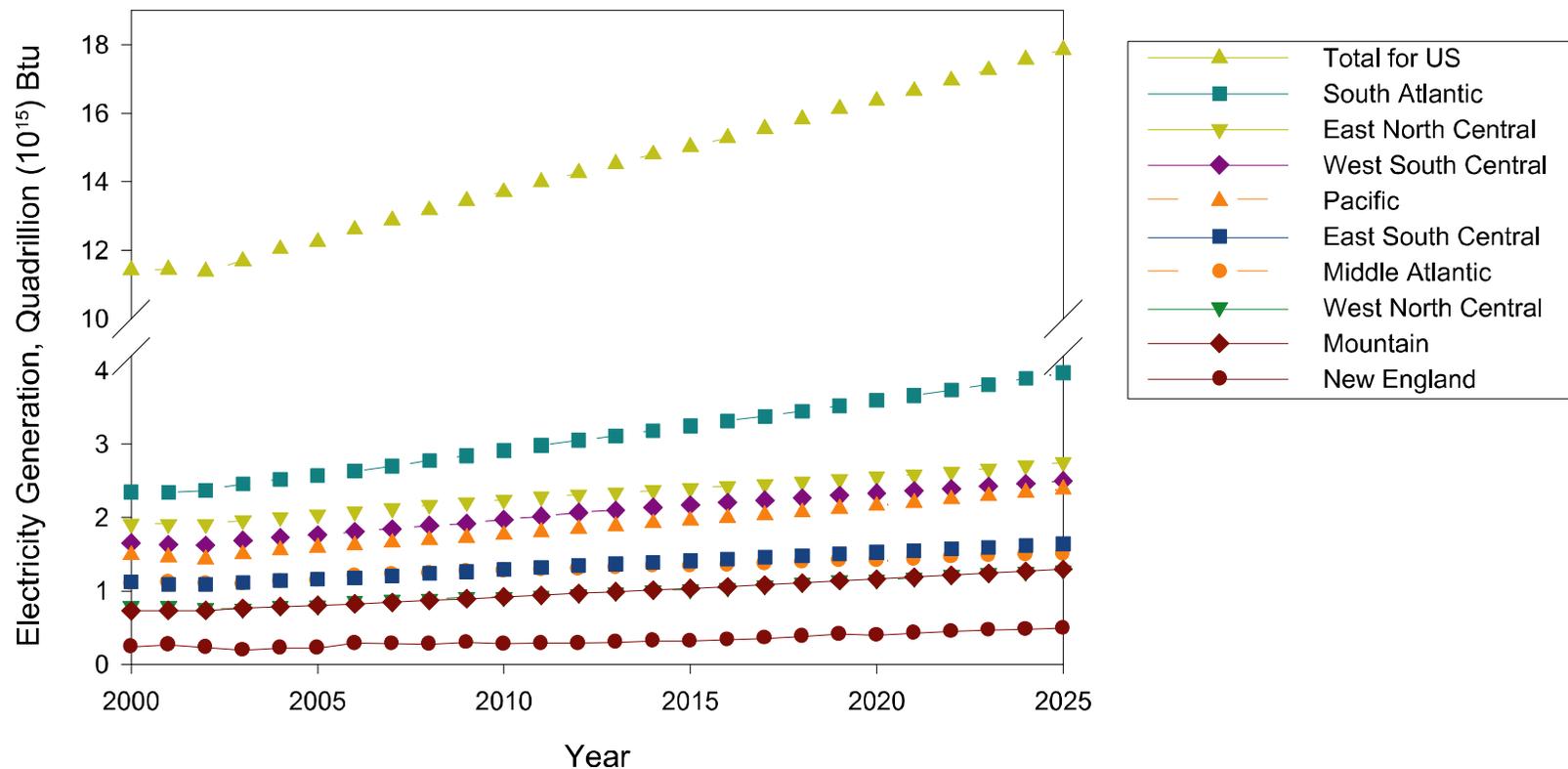
Less Water



More Water

Source: DOE/NETL (M. Chan, July 2002)

Electrical Energy Demand for Different Census Divisions, Projected by the Energy Information Administration, Department of Energy

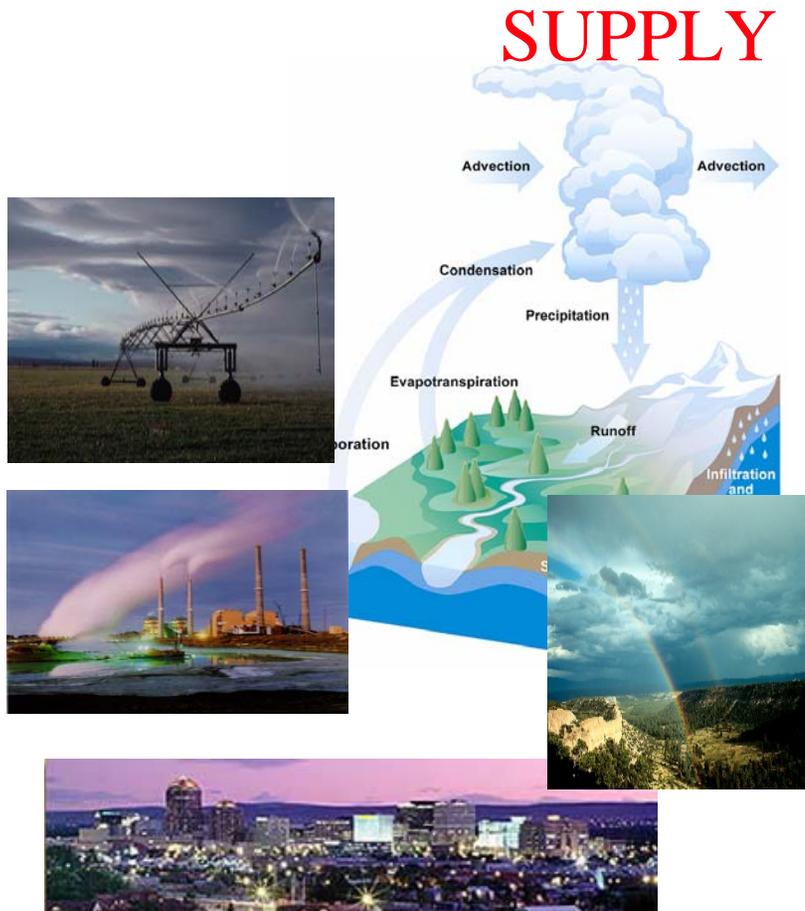


Water Is a Critical Resource

- Fast growing demand for clean, fresh water
- Increased demand for environmental protection and enhancement
- All regions of US especially vulnerable to water shortages
- Water availability impacts
 - Electricity supply and demand
 - Electricity grid topology
 - Societal and economic infrastructure sustainability



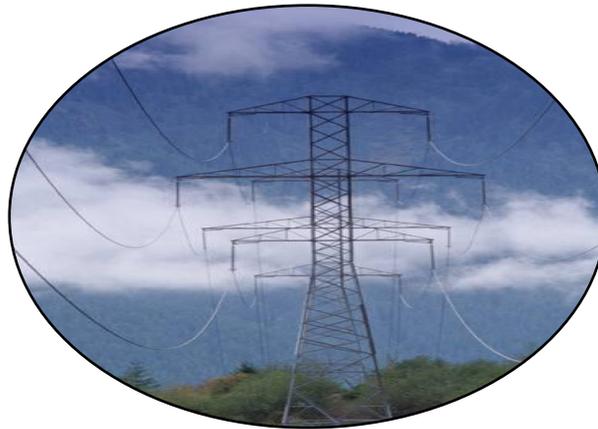
Consequences of Growing Electric Power and Water Demands



- More intensive management of water resources
- Greater integration between water and energy planning
- More watershed/regional planning
- New science and technology to support planning and management needs

Energy and Water are Inextricably Linked

Energy production and generation require water

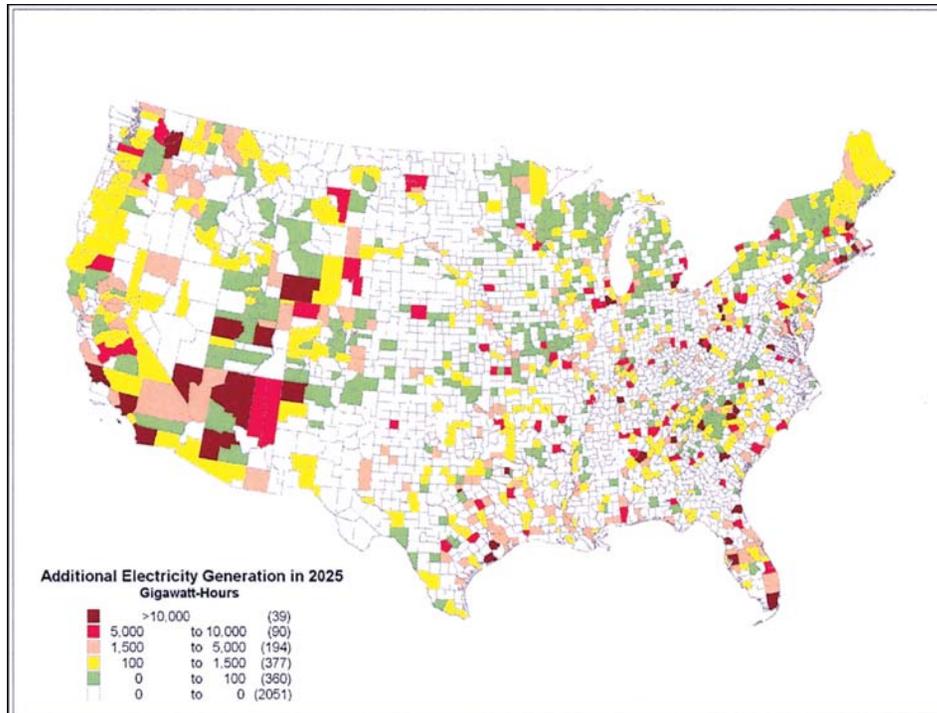


Water pumping, treatment, and distribution require energy

EPRI Research Reports

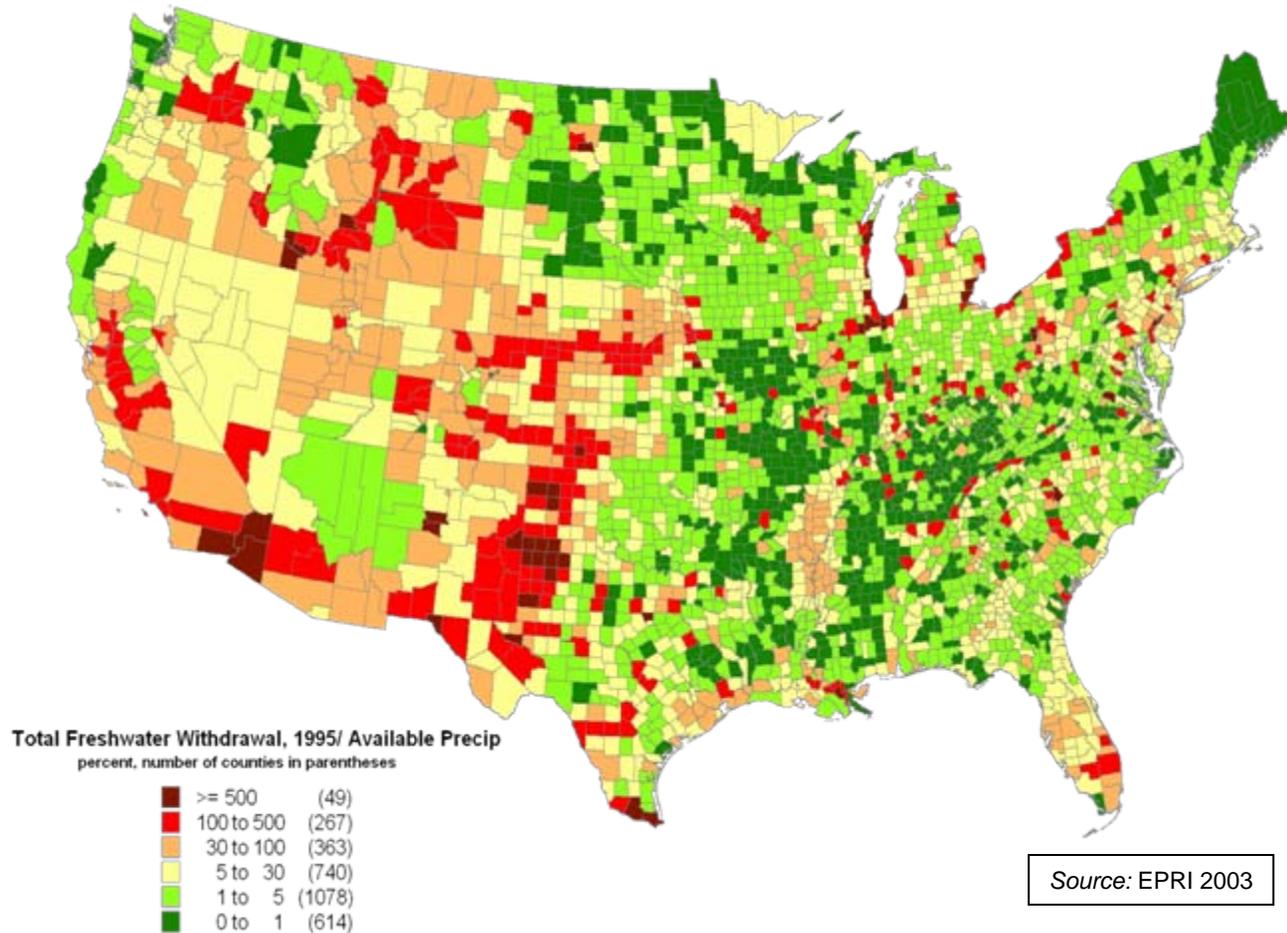
- Water & Sustainability (Volume 1): Research Plan (EPRI 1006784, 2002)
- Water & Sustainability (Volume 2): An Assessment of Water Demand, Supply and Quality in the U.S. – The Next Half Century (EPRI 1006785, 2002)
- Water & Sustainability (Volume 3): U.S. Water Consumption for Power Production – The Next Half Century (EPRI 1006786, 2002)
- Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply and Treatment (EPRI 1006787, 2002)
- Use of Degraded Water Sources as Cooling Water in Power Plants (EPRI 1005359, 2003) – Cosponsor CEC PIER Program
- Spray-Cooling Enhancement of Air-Cooled Condensers (EPRI 1005360, 2003) – Cosponsor CEC PIER Program
- A Survey of Water Use and Sustainability in the U.S. with a Focus on Power Generation (EPRI 1005474, 2003)
- Comparison of Alternate Cooling Technologies for U.S. Power Plants: Economic, Environmental and other Tradeoffs (EPRI 1005358, 2004)
- The Formation and Fate of Trihalomethanes in Power Plant Cooling Water Systems (EPRI 1009486, 2004) - Cosponsor CEC PIER Program

EPRI Research Published in Open Literature

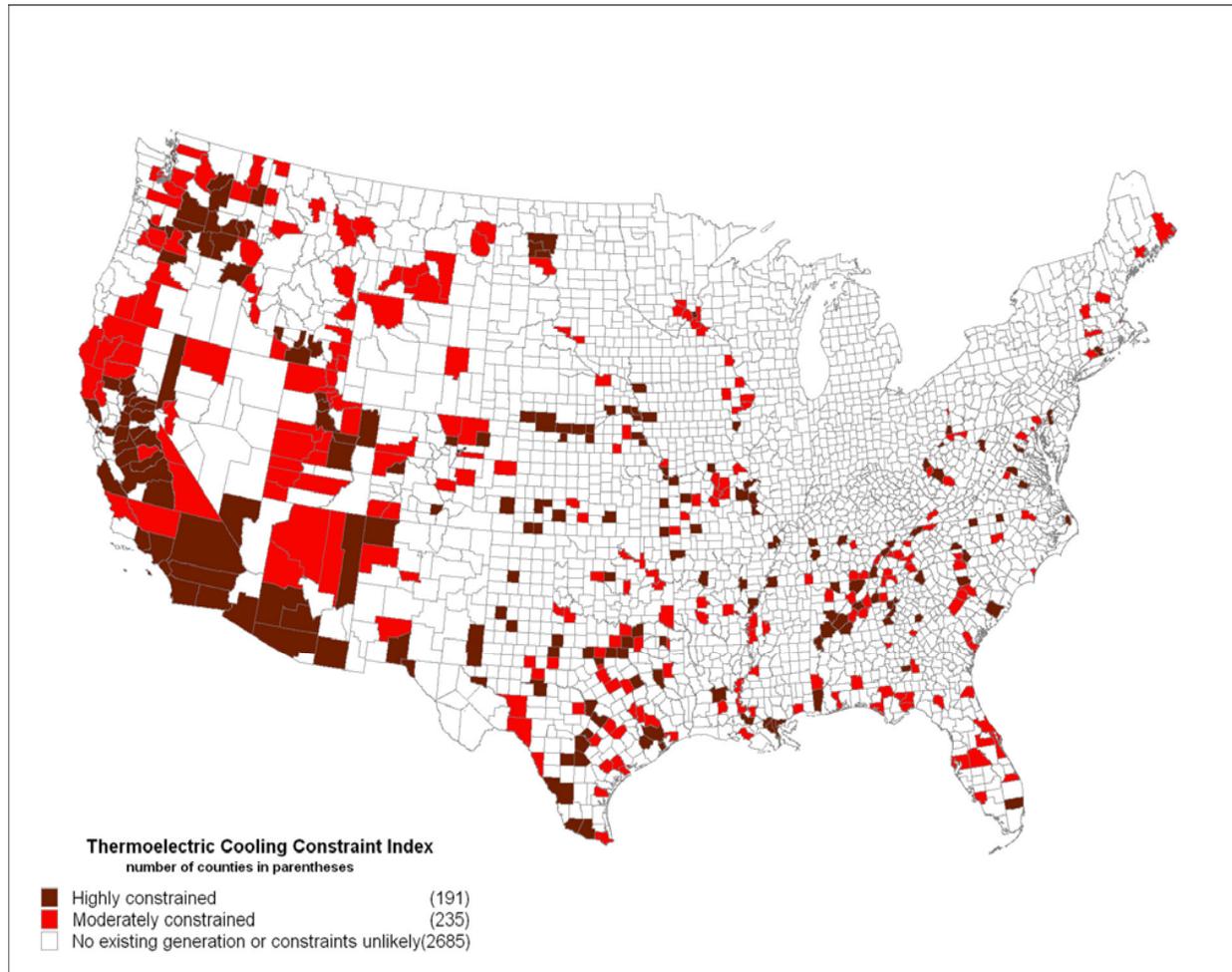


- Evaluation of the Sustainability of Water Withdrawals in the United States, 1995-2025
- Journal of the American Water Resources Association, October, 2005, pp.1091-1108

Sustainable Withdrawal Of Freshwater Is National Issue



Thermoelectric Cooling Constraint Index (2025)



EPRI Energy/Water Sustainability Research Program



**Pilot Spray Enhancement Testing
Crockett Cogeneration Station**

- Objective – Enable power companies to operate in an environment where there will be increasing limitations on water resource utilization and increasing demand for electric power
- Strategic elements
 - Regional public-private research partnerships
 - Power companies
 - Government and public agencies
 - National energy laboratories
 - Universities
 - Stakeholder groups
 - Integration of micro and macro approaches
 - Annual energy/water sustainability forum

Program Research Elements

- Watershed management decision support models
- Advanced cooling technologies
- Use of degraded water
- Watershed hydrology and biogeochemical cycling
- Market-based approaches
- Local and regional Infrastructure design and integration



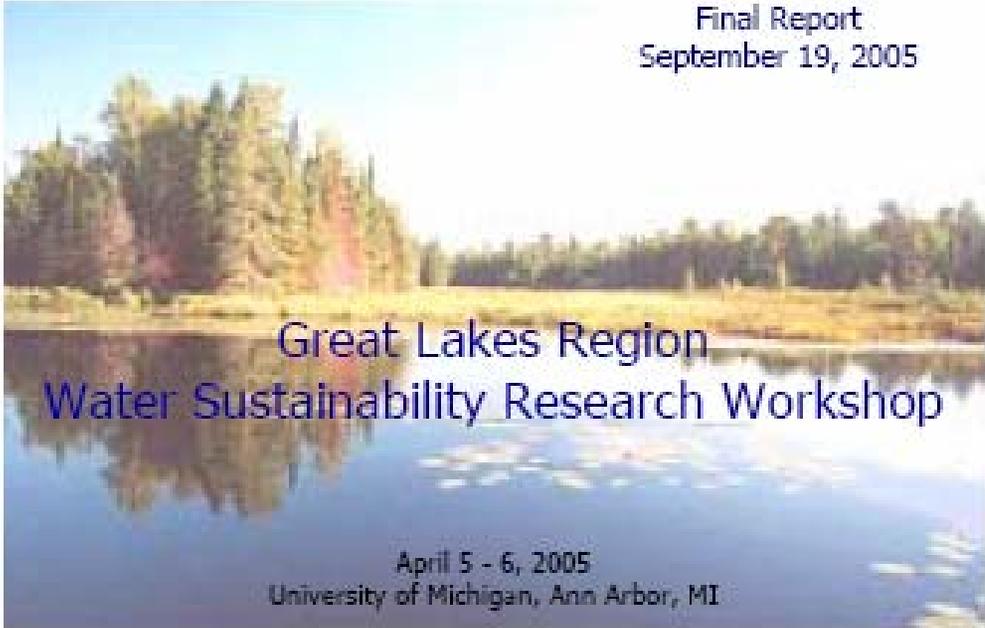
**Wet Surface Air Cooler
Test Unit for San Juan Plant**

Partnering with Government Agencies

- Federal Advisory Committee on Water Information (ACWI)
- Sustainable Water Resource Roundtable
- National Laboratory Energy/Water Nexus
- Federal Energy Act of 2005
- Energy-Water Efficiency Technology Research, Development and Transfer Program Act of 2005
- Energy/Water Sustainability Report to Congress
- Federal Water Sustainability Roadmap
- California/Western Energy/Water Center



Final Report
September 19, 2005



Great Lakes Region Water Sustainability Research Workshop

April 5 - 6, 2005
University of Michigan, Ann Arbor, MI

Sponsored by:
The Sustainable Water Resources Roundtable
<http://water.usgs.gov/wicp/acwj/swrr>

Hosted by:
University of Michigan ETC
(Environmental Technology Council)

Co-chairs:

Paul Freedman
WEF, SWRR &
Umno-Tech, Inc.

Robert Goldstein
Electric Power Research
Institute & SWRR

Peter Adriaens
Department of Civil and
Environmental Engineering,
The University of Michigan



SWRR Manager and Facilitator:
David Berry

Represented Sectors

- Power generation
- Agriculture and forestry
- Urban issues
- Manufacturing/industry
- Ecological protection
- Ethics, law and policy



Consensus Needs



- Improved understanding of critical water resource process and their impact on sustainability
- Decision support models/tools
- Better inventory of critical data
- New monitoring technologies
- Quantify “value” of water
- New policy and law to manage water on regional basis
- Conserve relevant specialists
- Collaboration

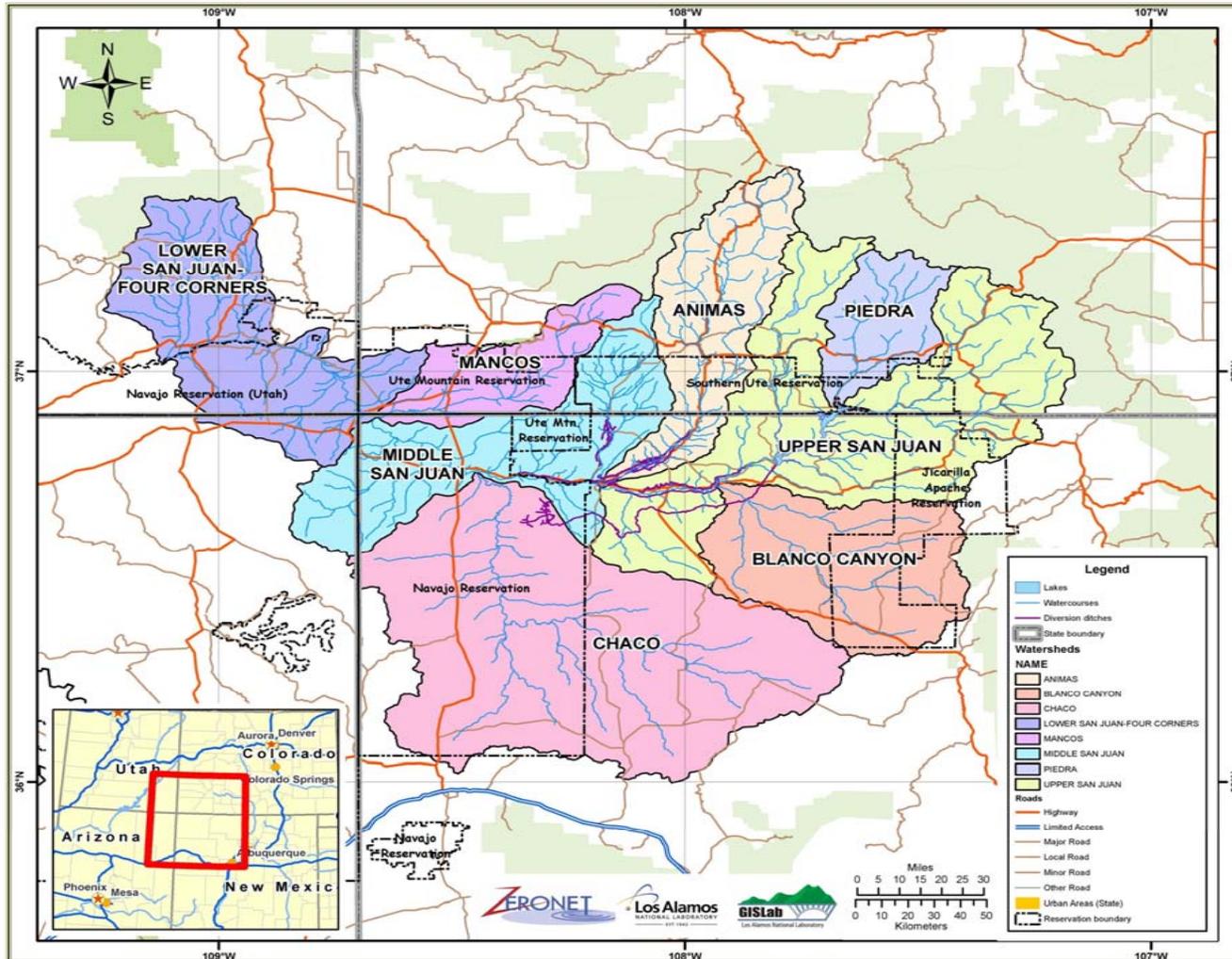
ZeroNet Water-Energy Initiative



ZERONET

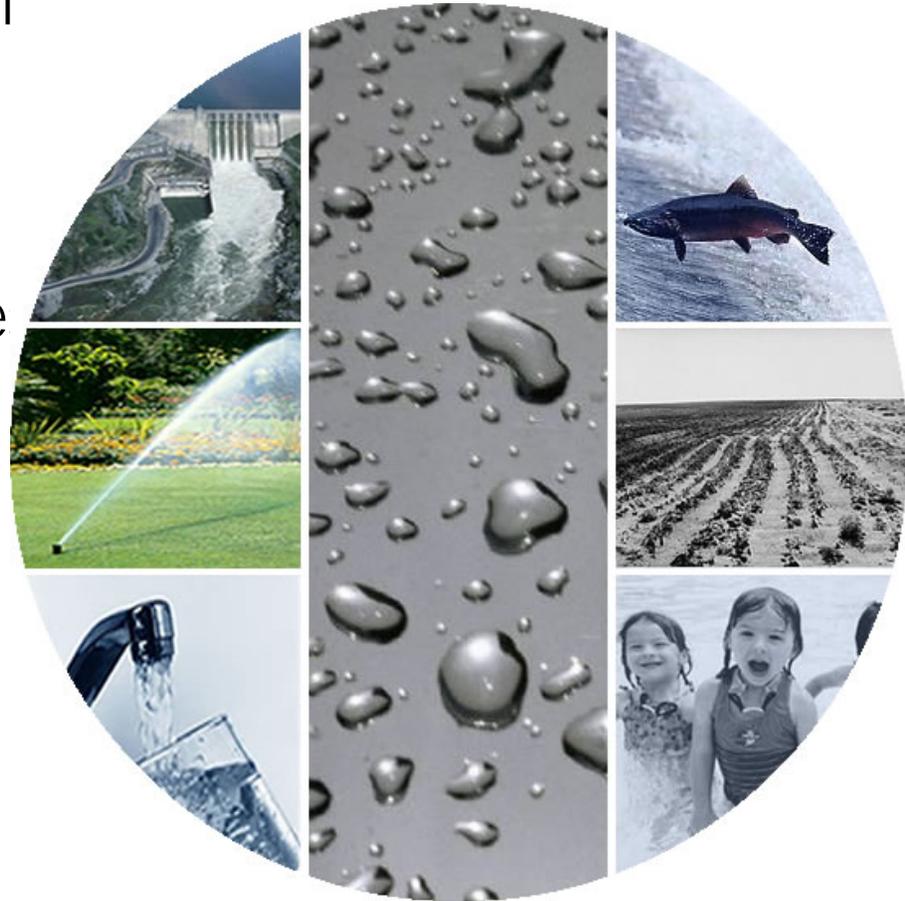


San Juan Basin



Power Generators Face Drought Related Challenges

- Recent drought in the San Juan Basin drove water supplies to their lowest level ever
- The San Juan Generating Station use 22,000 acre feet/year of San Juan River Water
- Power producers face major financial penalties if water restricts plant efficiency



Management Questions



- What additional water supplies become available as a result of advanced cooling technologies, use of degraded water, and watershed management strategies?
- How will regional growth affect water resources?
- How do different climate scenarios affect long-term water supply?

Solving the problem

Requires Science and Technology

Demonstration,
Test Beds, Outreach

Policy, Economic and
Market Analysis

Prediction &
Decision Support

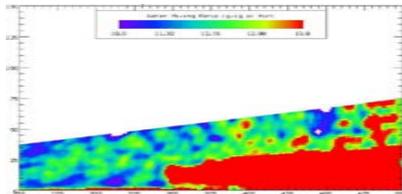
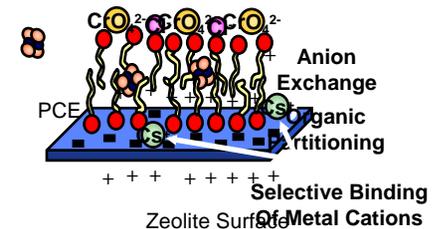


Monitoring &
Measurement
Science
& Technology

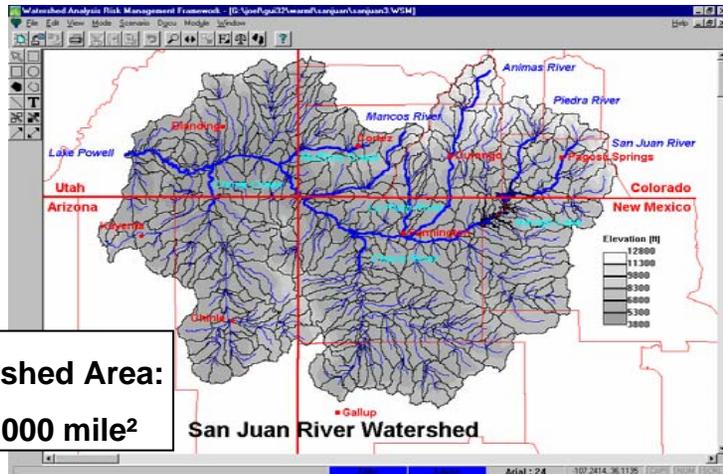
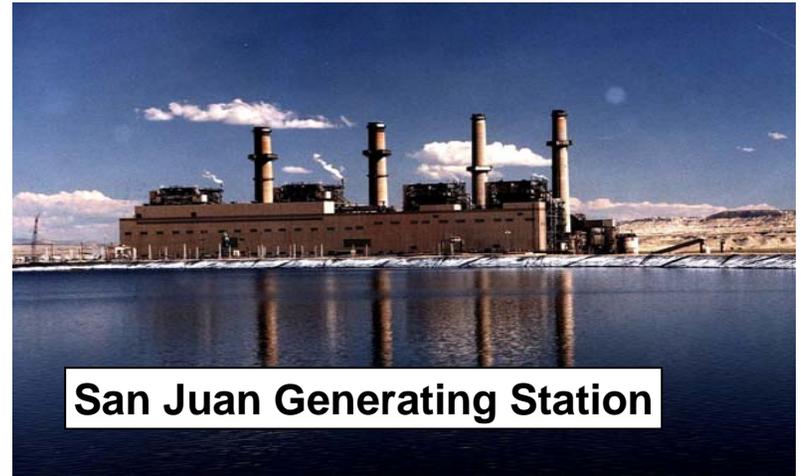
Advanced
Cooling Technology

Conservation, Efficiency
& Renewables

Degraded Water
Treatment and Use
Technology



San Juan River Basin



WARMF Application



Major Stakeholders In the San Juan Basin



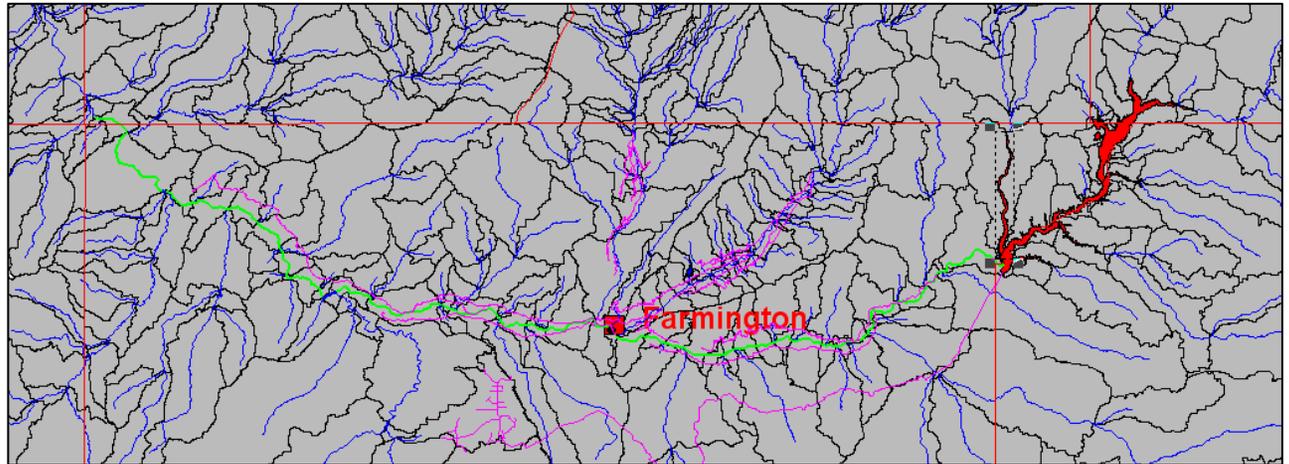
Razorback Sucker

- Navajo Nation – NIIP, Hogback, Fruitland, Navajo-Gallup
- Jicarilla Apache Nation
- Colorado Tribes – Southern Ute, Ute Mountain Ute, Animas-La Plata Project
- San Juan Chama Project (No ESA Section 7 consultation on San Juan effects)
- Municipalities/ San Juan Water Commission/ISC & OSE
- Industrial
- Non-Indian Agricultural
- Fly Fishermen
- Endangered Fish Species
- The Feds – USBR, USFWS, BIA, USFS, BLM

Impact of Reservoir Adjustment

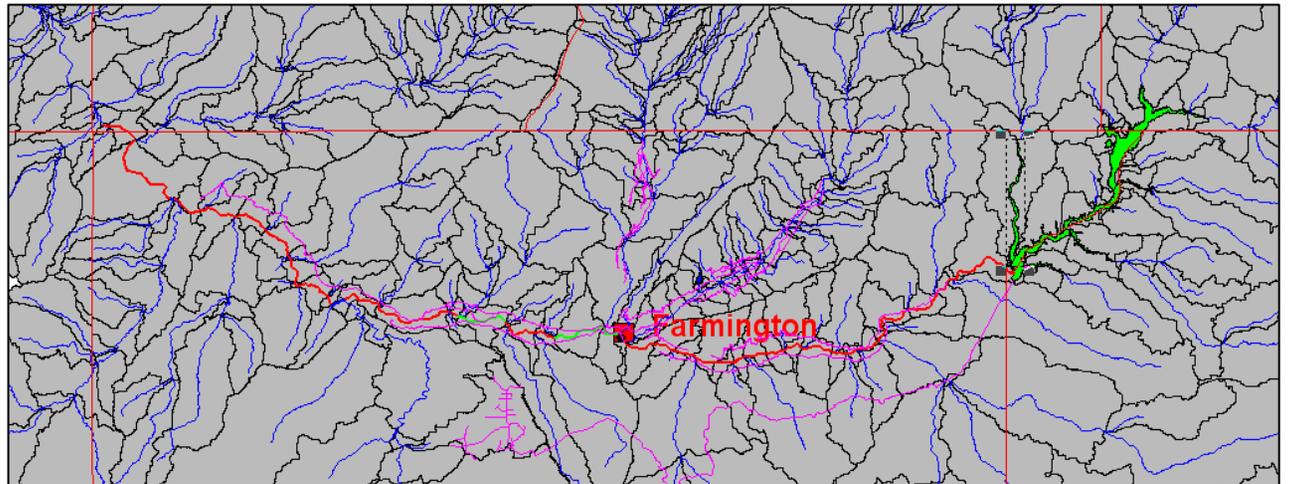
No Adjustment:

- Reservoir violates minimum elevation
- SJ River meets minimum flow requirement

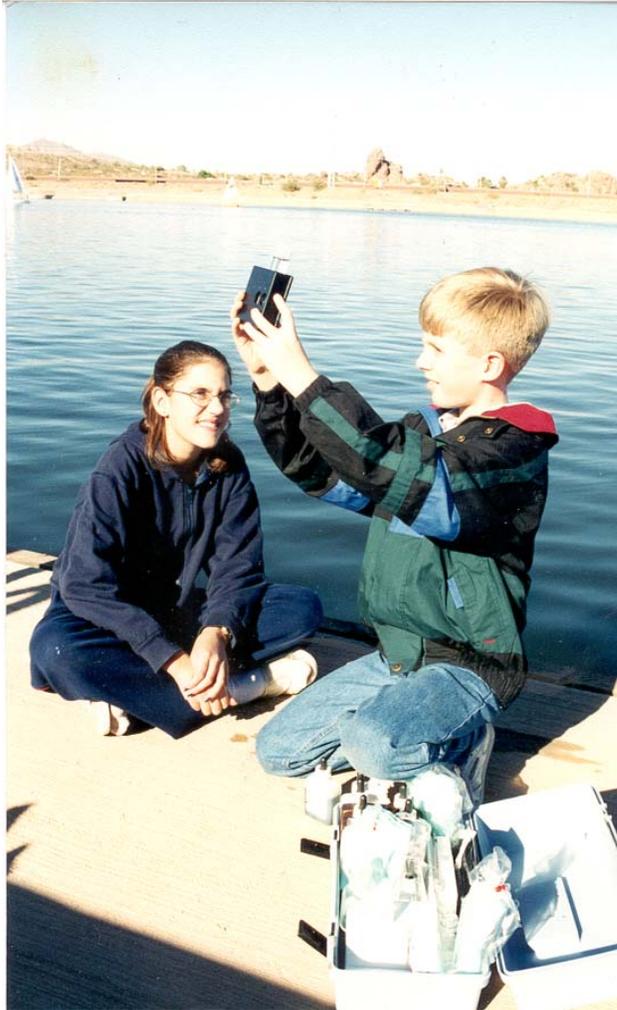


With Adjustment:

- Reservoir meets minimum elevation
- Most of SJ River violates minimum flow requirement



Some New Research Ideas



- Power plant siting decision support system that incorporates water resource management and new generating and advanced cooling technologies
- Regional (interstate) integrated energy/water infrastructure strategic planning decision support framework

Issues for USDOE Consideration



- Are there opportunities in terms of energy and/or water use efficiency that need to be explored?
- What are electric power-related vulnerabilities with respect to potential limitations in water supply? How can these vulnerabilities be reduced?
- What are water-related vulnerabilities with respect to potential limitations in electric power supply? How can these vulnerabilities be reduced?
- How should regional electricity and water infrastructures be organized and managed to address increasing electric power/water demands?