

# DOE-NETL Electric Utility-Water R&D Program



## *EPRI Water Advisory Council*

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Innovations for Existing Plants



# Presentation Outline

- **NETL Background**
- **Water & Energy Overview**
- **Electric Utilities & Water**
- **NETL Workshop**
- **DOE-NETL's Plans**



# National Energy Technology Laboratory



- **One of DOE's 17 national labs**
- **Government owned / operated**
- **Sites in:**
  - Pennsylvania
  - West Virginia
  - Oklahoma
  - Alaska
- **More than 1,100 federal and support contractor employees**



# What We Do

- Shape, fund, and manage extramural RD&D
- Conduct onsite research
- Support energy policy development



# Innovations for Existing Plants Program

- **Goal**

- Enhance environmental performance of existing fleet of coal power plants and advanced power systems

- **Objectives**

- Develop low-cost, integrated, non-complex technology to control emissions/releases (air, water, and solids) to the environment

- Provide high-quality scientific and technical information on environmental issues for use in future regulatory and policy decision making



# Water Issues in the News



# Power Plant Water Issues in Today's News



- **Company Ends Fight for Power Generator on NJ-NY Border**
  - *The Record, NJ, September 2002*
- **Official: Plants Would Use Too Much Water**
  - *The Idaho Statesman, ID, July 2002*
- **EPA Orders Mass. Power Plant to Reduce Water Withdrawals**
  - *Providence Journal, RI, July 2002*

# Power Plant Water Issues in Today's News

- **Duke Power Warns Towns in Charlotte, N.C., Area to Cut Water Use**
  - *The Charlotte Observer, NC, August 2002*
- **Generating Plant to Put Recycled Water to Use**
  - *Inland Valley Daily Bulletin, CA, August 2002*
- **Water at Pueblo, Colorado, Power Plant Slows to Trickle**
  - *The Pueblo Chieftain, CO, August 2002*





# Official: Plants Would Use Too Much Water



*Spokane River*

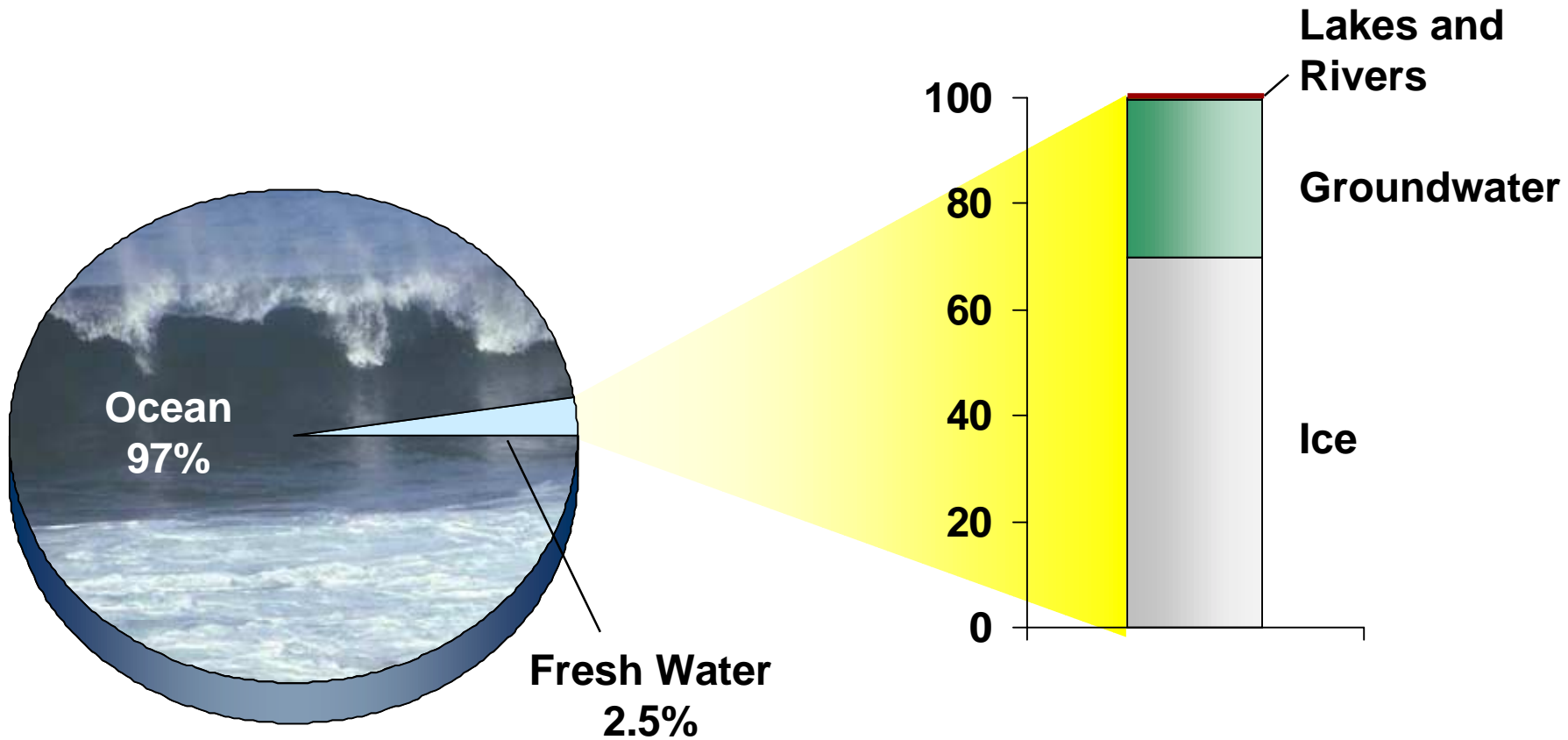
- 2 large electricity plants proposed for Washington-Idaho border
- 17 million gallons of water/day from Spokane-Rathdrum Prairie Aquifer
- Actual capacity of aquifer unknown  $\Rightarrow$  withdrawal too great?

# EPA Orders Massachusetts Power Plant to Reduce Water Withdrawals

- **1984 Brayton Point Station converted from closed cycle to once through cooling system**
- **Once through cooling system reportedly led to collapse of Mt Hope Bay fishery**
- **EPA requires PG&E to reduce current water withdrawal from 1 billion gpd to 60 million gpd**
  - **Cost estimates of new system:**
    - EPA: \$68 million
    - PG&E: \$254 million



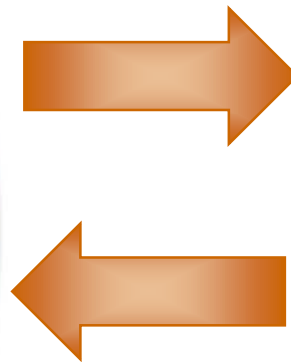
# Global Water Availability



# Water and Energy Inextricably Linked

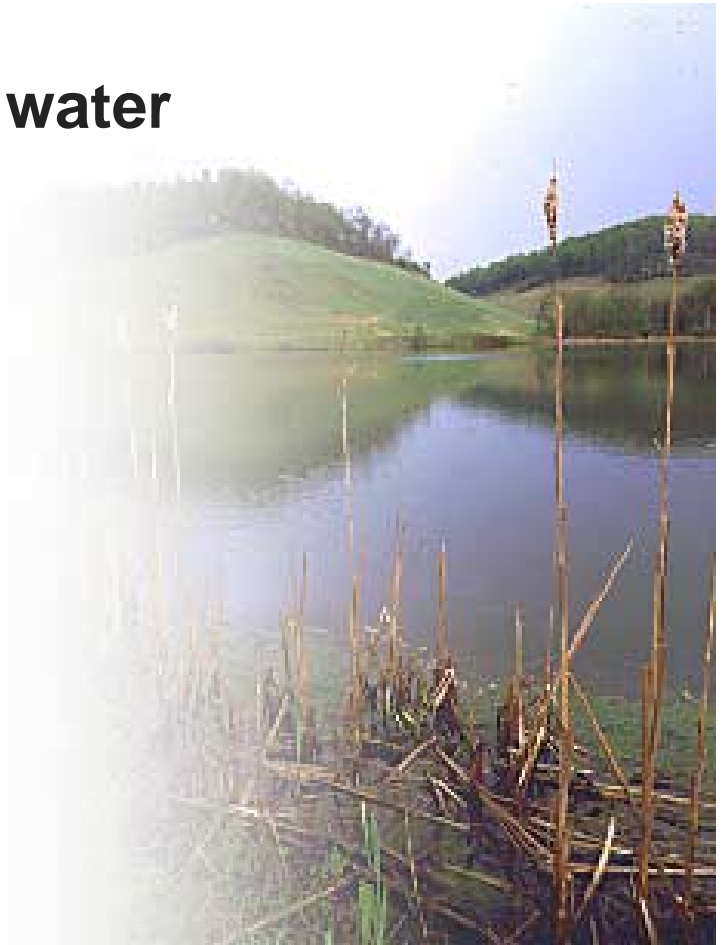
Thermoelectric power generation is second largest user of water in United States

80% of cost of treating, processing, and pumping water is for energy



# Issues and Ongoing and Planned Research

- **Electric utilities and cooling water**
- **Water quality trading**
- **Carbon sequestration**
- **Air-water interface**
- **Mining and watersheds**
- **Coalbed methane**



# Two Largest U.S. Fresh Water Use Categories



- **Power Plants**

- 131,900 Mgal / day used
- 3,300 Mgal / day consumed

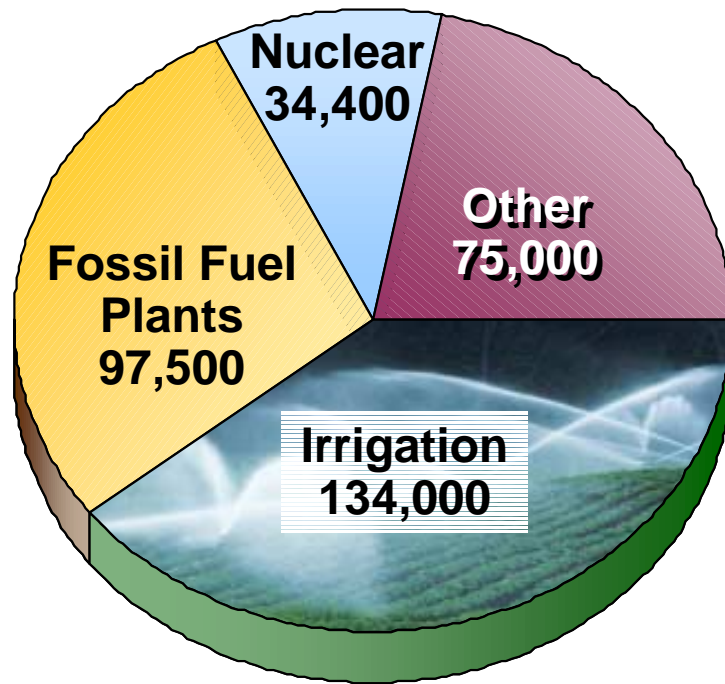


- **Irrigation**

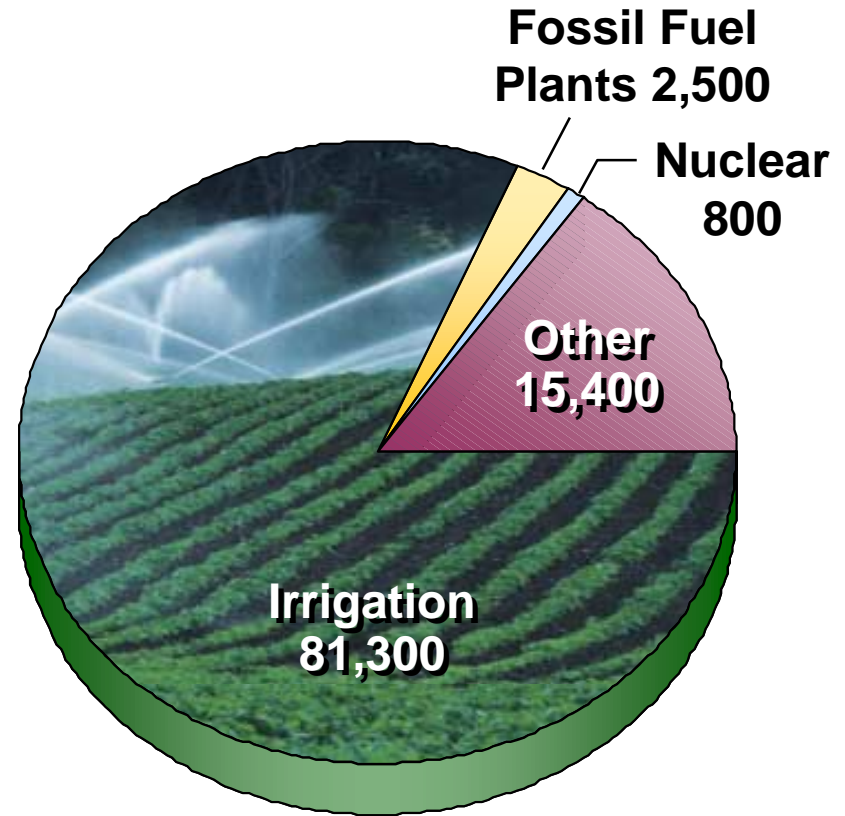
- 134,000 Mgal / day used
- 81,300 Mgal / day consumed

# Water Withdrawals and Consumptive Use

*Mgal / Day*

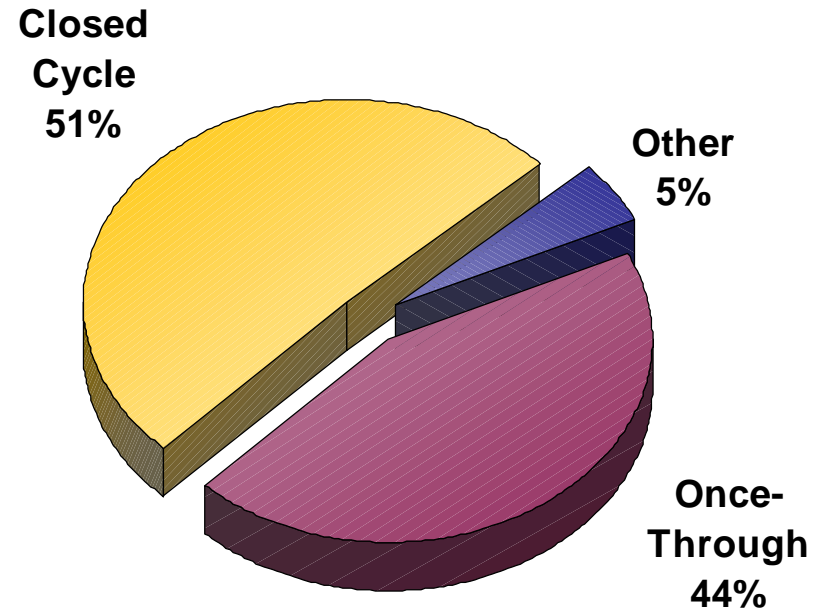


**Withdrawals**



**Consumptive Use**

# Potential Impact of Cooling Water Regulations on Existing Steam Electric Utility Boilers



**250,000 MW of Total Capacity  
Employing Once-Through  
Cooling**



# Zebra Mussels

## *Ongoing Research*

- Effect of calcium on zebra mussel populations and distribution
- Effectiveness of toxin from species of common soil bacterium of genus *Pseudomonas*



**Zebra Mussel Distribution in North America**



**Intake Grate Partially Blocked by Zebra Mussels**

# Water Quality Trading

## *Ongoing Research*



**Untreated Acid Mine Drainage in  
West Virginia Stream**

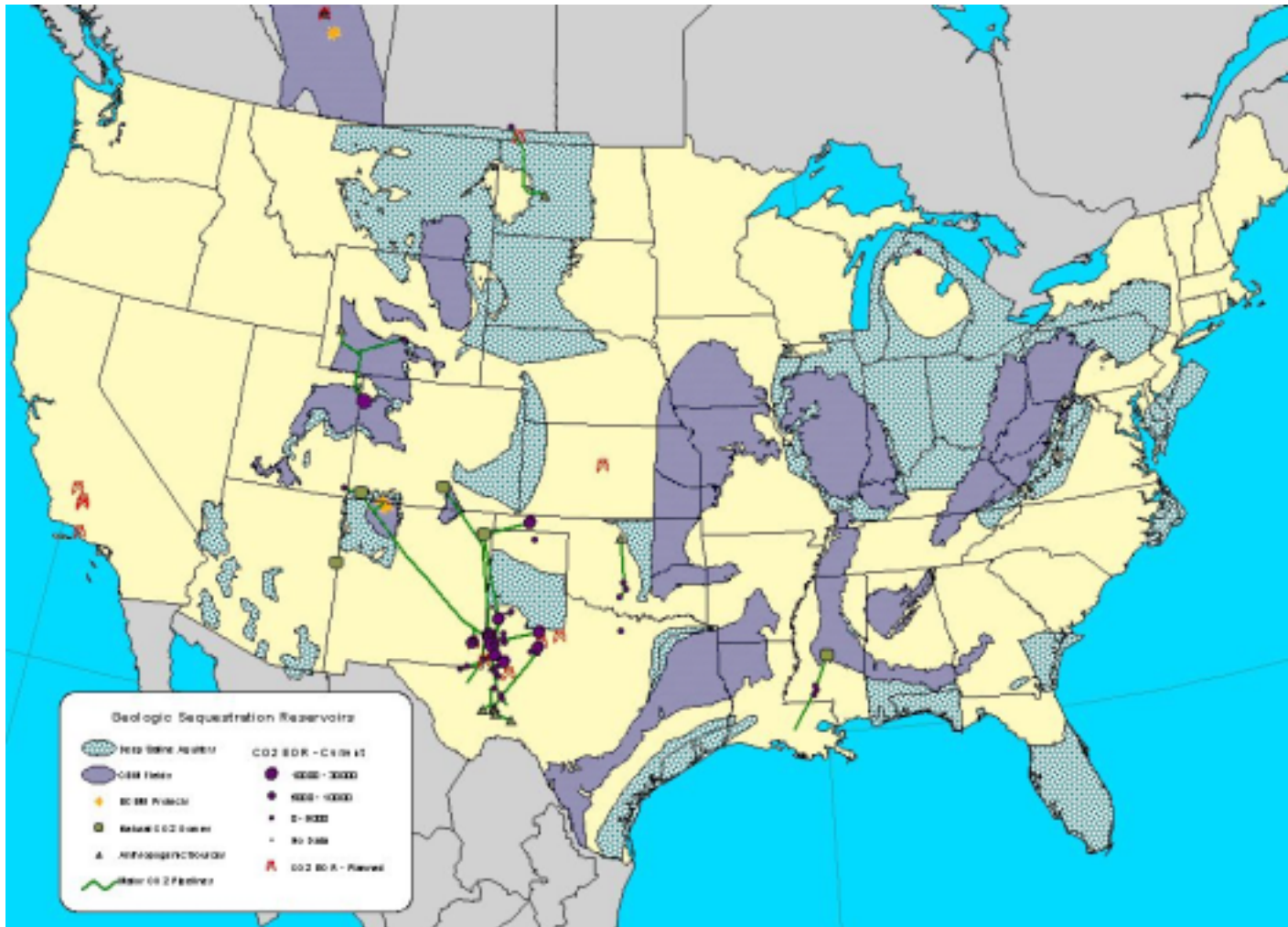
- **Initiate summer 2002 pilot project in Cheat River watershed in West Virginia**
- **Partnering with EPA, electric utility and coal companies, and regional and local watershed groups**
- **Project will involve surface mine reclamation, water-quality monitoring, and carbon sequestration**




# Water Quality Trading

- EPA proposed innovative, flexible approach to water quality improvement under Clean Water Act's TMDL program
- Would allow for water quality trading between point and non-point sources within a watershed
- Proven successful through pilot programs



# Carbon Sequestration Options



-  Deep Saline Formations
-  Deep Coal Seams
-  Enhanced Oil Recovery Fields

# Terrestrial Sequestration

## *Enhancing Eco-Assets*

- Partnering with electric-utility industry to reclaim disturbed lands in order to:
  - Capture and store carbon
  - Improve surface and groundwater quality
  - Provide wildlife habitat
  - Increase aesthetic and economic value



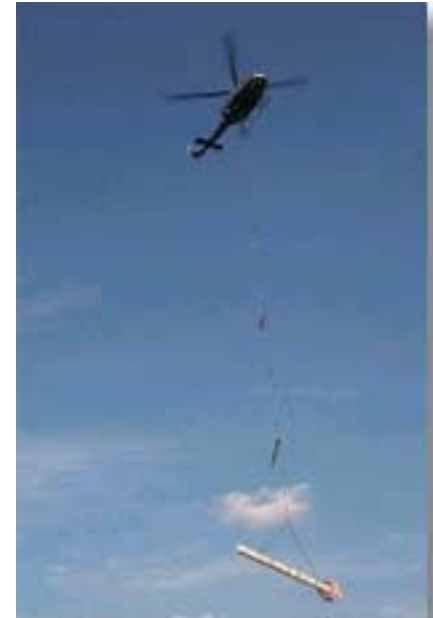
**Reclaimed Surface Mine**

# Mining-Watershed Science & Technology

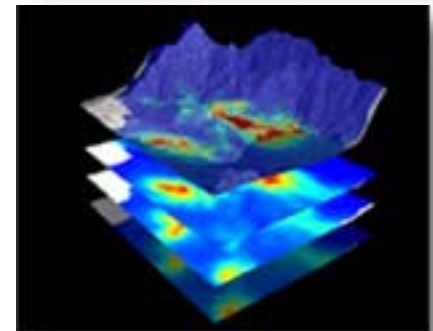
## *Ongoing Activities*

- **Remote sensing capabilities:**
  - Thermal infrared
  - Very low frequency
  - Magnetometry
  - Terrain conductivity
- **Can be used to survey and map water pollution sources**
- **Completed airborne remote sensing to assist EPA in mapping and controlling mercury ground water pollution at Sulfur Bank Superfund site**

**NETL  
Airborne  
Remote  
Sensing  
Platform**



**Conductivity  
“Stack” of  
Sulfur Bank  
Mercury Mine**



# Mercury Emissions and Water

## *NETL's Research Activities*

- Collaborating with TVA and EPRI to assess transport and transformation of Hg in power plant plumes
- Conducting Hg deposition sampling at Holbrook, PA, PM<sub>2.5</sub> monitoring site as part of national Mercury Deposition Monitoring Program



**Hg Wet Deposition  
Monitoring Station**

# Coalbed Methane (CBM)

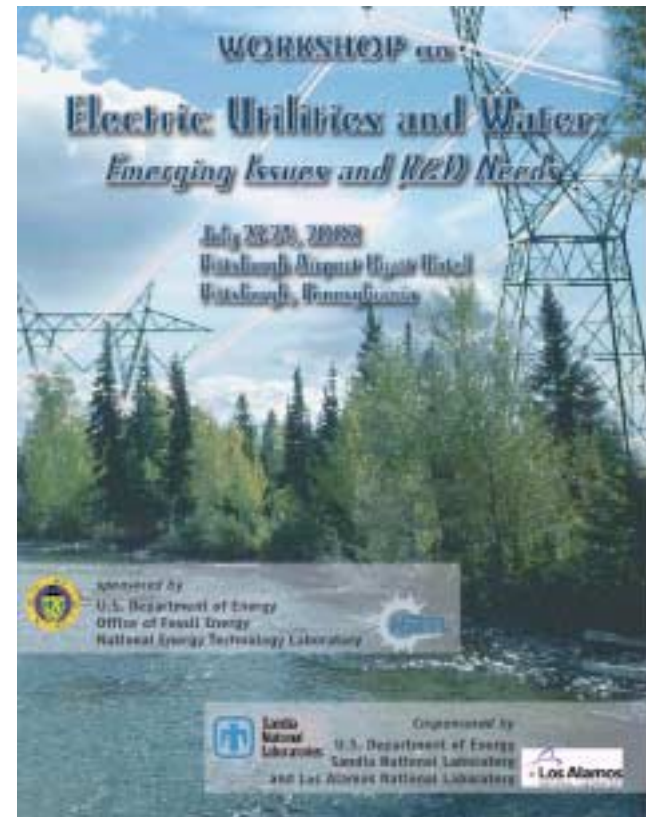
- **7.5% of total U.S. production**
- **Powder River Basin CBM**
  - 151.2 million Mcf CBM in 2000
  - 337.9 million barrels (14 billion gallons) of produced waters
- **Potential produce water issues**
  - Groundwater and drinking water contamination
  - Stream morphology alteration and sedimentation



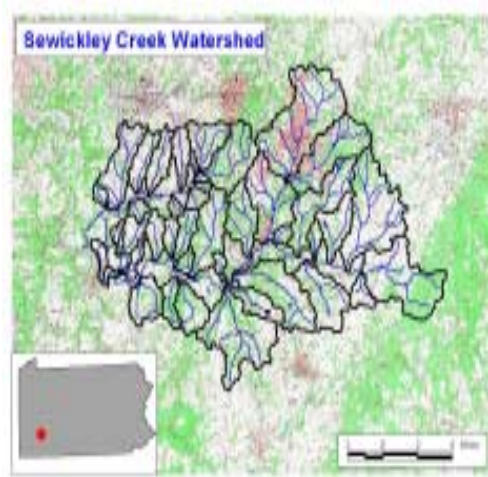


# Workshop on Electric Utilities and Water

- July 2002 two-day workshop addressing emerging water/energy R&D needs
- Second in a series of workshops sponsored by NETL, LANL, and Sandia
- Meeting of government, utility industry, academia, and regulatory representatives



# Key Issues Identified at Workshop



- **TMDL and permitting issues**
  - 316(b) regulations
  - future regulatory uncertainty
  - trading program and water credits
  - impact of non-point source and atmospheric deposition on water quality

- **R&D Needs and Opportunities**

- systems studies profiling water demands, alternative sources, and cooling requirements
- treatment technologies for trace level contaminants
- better watershed characterization technologies



# Key Issues Identified at Workshop

- **Obstacles of advanced cooling systems**

- cost effectiveness
- reliability
- efficiency



- **Obstacles of alternative cooling water sources**

characterization of source:

- availability
- suitability
- long-term water quality variability

# Mining to Generation

## *Reducing Water Use and Impacts*

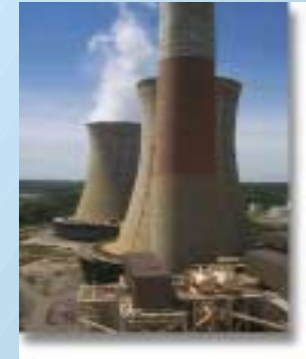
### *Mining*



### *Preparation*



### *Generation*



**Today: 3 gallons/kWh > Tomorrow: 1.5 - 2 gallons/kWh**

- AMD treatment
- Advanced planning
- Water quality trading
- Remote sensing/mapping

- Dry processes
- Advanced de-watering
- Water re-use/re-cycling

- Dry cooling
- Advanced sensors/controls
- Advanced wet cooling
- Alternative water sources
- Advanced treatment technology
- Water quality trading
- Advanced intake structures
- Water recovery, e.g., condensing heat exchangers



# Coal Drying to Reduce Water Consumed in Pulverized Coal Power Plants



- Lehigh University & Great River Energy collaboration
- Previous work demonstrates coal drying can reduce cooling tower makeup water requirements
- Additional benefits in heat rate and emissions
- Low temperature drying of subbituminous and lignite coals through recovery of low grade waste heat
- Examining fluidized and fixed bed drier designs