

## ***Use of Wetland Plant Species and Communities for Phytoremediation of Coalbed Natural Gas Produced Water and Waters of Quality Similar to that Associated with Coalbed Natural Gas Deposits of the Powder River Basin***

**DE-FG26-01BC15166**

### **Program**

The project was funded through congressional interest in research to investigate coalbed natural gas (CBNG) produced-water research in the Powder River Basin.

### **Project Goal**

The project goal is to evaluate CBNG produced water and determine what plants can best be irrigated with it. The specific focus of the project is to study how produced water with a characteristic saline-sodic fingerprint will interact with soil and water resources in CBNG production areas in the Powder River Basin (PRB) of Montana and Wyoming.

### **Performers**

*Montana State University  
Montana State Extension Water Quality  
(EWQ) Program  
Bozeman, MT*

### **Project Results**

The evaluation of PRB CBNG produced water found that identification of the right management practices and bioremediation processes can turn CBNG produced water into a valuable supplement to existing irrigation water supplies. Use of CBNG produced water with low concentrations of total salts resulted in 300-400% higher crop yields over non-irrigated crops.

### **Benefits**

The evaluation of PRB CBNG produced water resulted in several significant findings. Several agricultural crops species and wetland species have the capability of beneficially using CBNG produced water as either a sole or blended water source. Native saltbush and maritime barley, both perennial species with good production and forage potential, survived and produced commercially harvestable forage with sustained CBNG water irrigation. Essentially all qualities of PRB CBNG produced water



present opportunities either for enhanced livestock forage production and enhanced wildlife habitat along ephemeral streams and upland locations or for impoundments.

### **Background**

Within the past decade America's resources for gas production have dwindled, and exploration and development of new reservoirs has increased. One of the more recent supply sources of great promise is the CBNG being produced in the Powder and Tongue River basins of Wyoming and Montana.

One of the significant environmental production concerns is the amount of water and its mineral constituents associated with CBNG production. The water associated with much of the basin has the potential to be utilized in irrigation, stock watering, and wildlife enhancement efforts. What to do with the water is an immensely complex problem. It has generated a great deal of interest from the regulatory community, environmental groups, and agricultural community as well as a tremendous effort by the gas production companies to properly handle the water and to demonstrate beneficial uses for the produced water.

A January 2003 Environmental Impact Statement for CBNG development in Montana's PRB, prepared by the Bureau of Land Management and Montana's Department of Environmental Quality and Board of Oil and Gas Conservation estimated 2.5 trillion cubic feet of recoverable gas within the basin. Estimates from State and Federal agencies and industry are that 15,000-70,000 CBNG wells will be developed in the basin in the next 15-20 years. CBNG extraction requires significant volumes of water to be pumped from the coal seams to release water pressure that traps

the gas within the coals. The quantity, quality, and dispersal of this water needed to be evaluated

### **Project Summary**

The project tasks are to:

- Assemble, review and analyze the existing information on the chemistry of surface water and CBNG produced water.
- Conduct greenhouse investigations of the potential of phytoremediation, or wetland filtration, techniques using selected halophytes and superaccumulator plants, biofilters, and precipitation reactions.
- Perform laboratory study of acceptable soil types in conjunction with CBNG produced water electrical conductivity-sodium adsorption ratio (EC-SAR) combinations from wetland filtration sites and discharge points to rangeland and irrigated fields.
- Establish baseline hydrologic, stratigraphic, and chemical characterization of coal-bearing aquifers and water contained within those aquifers in the Montana portion of the Powder River watershed.

- Build baseline data on CBNG development impacts on local and regional hydrologies and criteria for CBNG produced water withdraws that will minimize impacts to local and regional groundwater systems.

Baseline surveys and a literature search of PRB CBNG produced water found that it is characterized as generally non-saline and ranges from slightly to excessively sodic. The total dissolved solids concentration ranged from 270 mg per liter to 2,300 mg per liter with an average of 850 mg per liter. Sodicity ranged from 5 to over 50, with an average SAR of 12 throughout the PRB. In general, the salinity and sodicity are lower in the southeastern portion of the basin. The maximum salinity is just north of the Montana-Wyoming border, and the highest sodicity levels are in the extreme northwestern part of the basin near the Montana-Wyoming border. The study found that CBNG produced water undergoes rapid chemical changes once it is exposed to the atmosphere. The water has a rapid increase in sodicity or SAR levels and an increase in alkalinity (pH level).

Phytoremediation for removal of salts and sodic concentrations from the CBNG produced water was determined not to be fea-

sible as a management practice for large volumes of produced water. The wetland plant species survived, however, in some instances due to the arid conditions; high evaporation rates caused the soils to increase in salinity and sodicity over time.

Use of CBNG irrigation for native grasses resulted in uptake of total salt,s and when harvested or grazed the excess salts were removed from the system. The agricultural crop and wetland species most capable of beneficial use of CBNG produced water were maize, hay, forage barley, and western and tall wheatgrass. Irrigation with CBNG water with low total salt yielded crops 300-400% higher in volume than the same crops grown under non-irrigated conditions.

Overall, the project found that when used in combination with existing water resources and on selected compatible soils, proper irrigation management with CBNG produced water can be effectively used for irrigation of forage for agricultural use and wildlife enhancement.

### **Current Status (August 2005)**

In the final year of the project, research will continue on defining the appropriate limits for SAR concentrations and management practices for beneficial use of CBNG produced water.



Lysimeter set up for simulated wetland system..

**Project Start:** September 1, 2001

**Project End:** September 30, 2007

**Anticipated DOE Contribution:** \$1,649,000

**Performer Contribution:** \$432,000 (20% of total)

#### **Other Government Organizations Involved**

Bureau of Land Management

#### **Contact Information**

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