

# PROJECT facts

U.S. DEPARTMENT OF ENERGY  
OFFICE OF FOSSIL ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Environmental  
Solutions

06/2005



## AIRBORNE REMOTE SENSING OF PRODUCED WATER FROM COALBED NATURAL GAS DEVELOPMENT

### PARTNERS

**National Energy Technology Laboratory**

Pittsburgh, PA

**JM Huber Corporation**

Sheridan, WY

**Fidelity E&P**

Denver, CO

**Wyoming DEQ**

Cheyenne, WY

**BLM**

Buffalo, WY

**U.S. Geological Survey**

Denver, CO

### MAIN SITE

**Powder River Basin**

WY & MT

### Background

The Powder River Basin covers 12,000 sq. miles in Wyoming and Montana. The development of coalbed natural gas (CBNG) resources in the Powder River Basin has resulted in large volumes of produced water that are disposed of on the surface by land application or returned to groundwater aquifers via infiltration basins or injection wells. By 2003 over 26,000 coalbed natural gas wells in Wyoming were producing nearly 1 billion cubic feet of natural gas per day. Along with the coalbed natural gas production, 1.6 million barrels of produced water per day are being brought to the surface. The management of such large volumes of produced water constitutes a major challenge to the oil and gas industry as well as federal and state regulators. In-house research from NETL-Pittsburgh and the University of Pittsburgh is implementing airborne magnetic and electromagnetic surveys of selected active and proposed CBNG areas.

The survey technique uses helicopters to detect near-surface aquifers (depth <150 ft) beneath and adjacent to produced water impoundments. Monitoring the effect of produced water on near-surface aquifers using airborne electromagnetic surveys is an effort to prevent problems and find and correct unfavorable situations. The intent of the survey is to evaluate the use of airborne electromagnetic surveys for large-scale mapping of near-surface aquifers and movement of produced water plumes.



DOE is using remote sensors suspended from helicopters to map the flow of groundwater.

### Project Description/Accomplishments

NETL sponsored flyovers to survey approximately 70 sq. miles in the Wyoming portion of the Powder River Basin in 2003 over proposed and active CBNG areas. In July 2004, portions of two areas were reflown to determine changes in groundwater hydrology that had occurred in response to a year of CBNG activity. Two new areas



## CONTACTS

### Sue Mehlhoff

Project Manager  
SCNGO  
918-699-2044  
sue.mehlhoff@netl.doe.gov

### James Sams

Principal Investigator  
National Energy Technology  
Laboratory  
412-286-5763  
james.sams@netl.doe.gov

## PROJECT DATA

### 03(04)-ER-01

Oct. 1, 2005-Sept. 30, 2004

### Total Project Value

\$1,680,000

### DOE/Non-DOE Share

\$1,680,000

## CUSTOMER SERVICE

1-800-553-7681

## WEBSITE

[www.netl.doe.gov](http://www.netl.doe.gov)

with in-stream impoundments were flown also. In deployment of the airborne survey, a helicopter flies a prepared grid pattern about 200 feet above the ground. Two types of sensors are deployed that can detect wells by the magnetic properties of their steel casing or that can detect in-ground conductors such as aquifers by the small currents that flow within them. In conjunction with the airborne survey, ground conductivity surveys are conducted on small subareas of the airborne survey to validate airborne results.

Follow-up ground conductivity measurements found that the leaking water was four times more conductive than the produced water in the impoundment, the suspected source of the leaking water. This indicates that the leaking water is either dissolving the salts in the strata through which it is traveling or it is displacing more conductive natural groundwater from these strata. This may indicate that at this site, the produced water is diluting the more conductive native groundwater and is actually improving water quality in the near-surface aquifers.

Helicopter electromagnetic surveys were found to rapidly determine the quality of shallow groundwater systems for large areas. This information can identify areas of high quality groundwater so that regulatory agencies can specify a management strategy for produced water that will protect this resource. Likewise, areas of poor quality groundwater can be identified and the produced water can be managed so that the groundwater quality is improved. Further information from electromagnetic surveys can be used to determine the type and location of future impoundments and groundwater monitoring wells.

NETL has developed and filed a patent for Conductivity Depth Image viewer software. The software allows for more effective placement of groundwater monitoring wells and early detection of leaks from lined pits.

## Benefits/Impacts

Helicopter electromagnetic surveys are a quick, cost-effective way to determine the natural conditions of shallow aquifers prior to CBNG development and to monitor the changes brought about by implementation of various management options for produced water. The ability to map groundwater aquifers and buried river channels will allow more effective placement of groundwater monitoring wells. Aeromagnetic surveys can be used to confirm the locations for existing coalbed natural gas wells, and can identify old wellbores that are not accounted for on state well records and not visible by surface inspection. The study has demonstrated that helicopter electromagnetic surveys can identify potential leaks from lined impoundments several months before seepage is visible on the surface, which allows for more timely correction and remediation.



*Ground conductivity survey in the Powder River Basin.*