ENHANCED COAL BED METHANE PRODUCTION AND SEQUESTRATION OF CO_2 IN UNMINEABLE COAL SEAMS

Semi-Annual Technical Progress Report
April 1, 2003 through September 30, 2003

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DISCLAIMER

ABSTRACT

This is the fourth semi-annual Technical Progress report under the subject agreement. During this report period, progress was made on developing the south well site, reclaiming the north access road, and assessing drilling at the north well site. These aspects of the project, as well as progress on public communications, are discussed in detail in this report.

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ATTACHMENTS

INTRODUCTION

The availability of clean, affordable energy is essential for the prosperity and security of the United States and the world in the 21st century. Emissions of carbon dioxide (CO_2) into the atmosphere are an inherent part of electricity generation, transportation, and industrial processes that rely on fossil fuels. These energy-related activities are responsible for more than 80 percent of the U.S. greenhouse gas emissions, and most of these emissions are CO_2. Over the last few decades, an increased concentration of CO_2 in the earth's atmosphere has been observed. Carbon sequestration technology offers an approach to redirect CO_2 emissions into sinks (e.g., geologic formations, oceans, soils and vegetation) and potentially stabilize future atmospheric CO_2 levels. Coal seams are attractive CO_2 sequestration sinks, due to their abundance and proximity to electricity-generation facilities. The recovery of marketable coalbed methane (CBM) provides a value-added stream, potentially reducing the cost to sequester CO_2 gas. Much research is needed to evaluate this technology in terms of CO_2 storage capacity, sequestration stability, commercial feasibility and overall economics.

CONSOL Energy Inc., Research & Development (CONSOL), with support from the US DOE, has embarked on a seven-year program to construct and operate a coal bed sequestration site composed of a series of horizontally drilled wells that originate at the surface and extend through two overlying coal seams. Once completed, all of the wells will be used initially to drain CBM from both the upper (mineable) and lower (unmineable) coal seams. After sufficient depletion of the reservoir, centrally located wells in the lower coal seam will be converted from CBM drainage wells to CO_2 injection ports. CO_2 will be measured and injected into the lower unmineable coal seam while CBM continues to drain from both seams. In addition to metering all injected CO_2 and recovered CBM, the program includes additional monitoring wells to further examine horizontal and vertical migration of CO_2.

This is the fourth Technical Progress report for the project. Progress this period was focused on dewatering and well assessment at the north well site and site development work at the south well site. This report provides a concise overview of project activities this period and plans for future work.

EXPERIMENTAL

Project well sites have not yet been completed; therefore no experimental work has begun.

RESULTS AND DISCUSSION

STATUS OF COOPERATIVE AGREEMENT

Quarterly project status reports (DOE F 4600.6) were issued to DOE on April 16 and July 17, as required. In May, CONSOL executed amendment A004, which obligated additional DOE funds to the project. CONSOL met with the DOE COR for the project on May 20 to review progress and discuss future plans. In June, a paper was presented at DOE's Carbon Sequestration Program Review 2003. A revised budget and spending plan for the project was formulated in August. A formal proposal, which detailed the budget revisions for the project, was submitted to DOE in September.

CONSTRUCTION PROGRESS – NORTH WELL SITE

The three completed horizontal wells at the north well site were identified (by CNX Gas) as MH-3, MH-4, and MH-5. Well MH-3 was drilled in a southeast direction in the Pittsburgh seam (3,000 feet), well MH-4 was drilled in a southwest direction in the Pittsburgh seam (3,000 feet), and MH-5 was drilled in a southeast direction in the Upper Freeport seam (~2,200 feet).

In April, the well site was partially reclaimed and contractors completed installation of the sump tubing and pumping units for the three wells. In addition, a source of liquid propane gas was established at this location to fuel the engines that drive the pumping units. Site photographs are shown in Attachment A.

Excessive spring/summer rains made access to the north well site difficult. As a result, CNX Gas opted to establish a bank of water storage tanks along the railroad right-of-way (RR ROW) just west of the south well site. A three-inch plastic pipeline was then routed from the north well site to the tank location along the RR ROW. This arrangement allowed produced water from the north wells to gravity flow to the tanks. Consequently, water-hauling trucks could readily access the tanks along the RR ROW.

Efforts to dewater the north wells began in April and continued throughout the summer months. Water production at well MH-3 was significant. CNX Gas reported initial water production at well MH-3 at ~100 barrels/day (4,200 gallons/day) and declining over two months to ~30 barrels/day, as expected. Although the well design and completion techniques were identical for all three wells, wells MH-4 and MH-5 were afflicted by down-hole pumping problems that impeded the dewatering effort. Drill cuttings, which had apparently collected in the sumps of these wells, would choke the pumps and lead to mechanical failures in a short period of time. On multiple occasions, service contractors were employed to enter the wells to pull and repair the pumps. In June, the pumps were repositioned in the sumps. This action appeared to resolve the performance of the pumps at wells MH-4 and MH-5. However, for reasons that are not yet fully understood, water production at these two wells was minimal in relation to well MH-3. Apparently, communication between the sump and the horizontal component of the well (in the coal seam) has not been fully established. A communication gap linked to the well completion may be limiting water and subsequent gas production from these wells. This issue is discussed further in the next section of this report.

Dewatering efforts at the three north wells continued through August. In September, CNX Gas elected to shutdown the pumping units until an alternative plan was formulated. Despite only minimal water production from wells MH-4 and MH-5, accounting records indicated that water produced/disposed from the north wells totaled more than 311,000 gallons.

The WVDEP inspector(s) overseeing the well permits mandated specific reclamations to both the access road and the well site. Despite setbacks due to weather, significant reclamation work was completed this period. These reclamations included: installing an access gate, re-establishing ditch lines along the access road, replacing damaged culverts, compacting the road surface, reclaiming the drill pits, and extensive grass seeding.

PROGRESS ON WELL ASSESSMENT

In March, at another location, CNX Gas (with its own funds) completed two horizontal wells using the same well design and completion techniques as the three existing project wells. Similar to the two project wells described above, water production at the CNX Gas wells (identified as BH-3A and BH-3B) was minimal and non-existent at times. Consequently, CNX Gas decided to pursue remedial action for these wells and explore alternative well designs for future horizontal wells.

In July, drilling contractors were re-deployed to the CNX well site. The objective was to establish down-hole communication by removing the sump casing and re-entering both the sump and the horizontal element of the well. Contractors successfully reworked well BH-3A and established communication. Following well completion in August, well BH-3A was producing significant volumes of both water and CBM. As a result, CNX Gas plans to similarly re-enter the project wells at the north well site.

CNX Gas recently embarked on another horizontal drilling project in Greene County, Pennsylvania, which employs revised well completions. Following the completion and assessment of this work, CNX Gas will devise a drill plan for the remaining DOE project wells, beginning with those at the south well site.

CONSTRUCTION PROGRESS - SOUTH WELL SITE

Excavation work along the RR ROW and at the south well site was completed in April. Groundwater drainage systems were constructed as required. Numerous truckloads of stone were delivered and dispersed along the RR ROW and at the well site. Photographs of the south site are included in this report as Attachment B. As discussed above, the drill plan for this site has not yet been finalized. Consequently, the installation of the construction trailers at this site has been postponed.

PROGRESS - CENTRAL WELL SITE

Well permits for the two previously revised well designs at the central well site were approved by WVDEP in June. Site preparation work at this well site has not yet begun.

PROGRESS ON PUBLIC COMMUNICATIONS

A paper titled "Enhanced Coal Bed Methane (CBM) Recovery and CO_2 Sequestration in an Unmineable Coal Seam" was prepared/presented (Attachment C) at DOE's Second Annual Conference on Carbon Sequestration, May 5 – 8, 2003, in Alexandria, Virginia. The paper was submitted to the DOE COR and Patent Counsel.

CONCLUSION

As directed by WVDEP inspectors, extensive reclamation work was completed along the north access road and well site. Dewatering of the three completed wells at the north well site began, but was impaired by down-hole communication gaps linked to the sump design. Remediation measures for these wells were established and will likely be implemented next spring. Outside of this project, CNX Gas has begun work on another horizontal drilling project, which employs revised well completions. Pending the results of this project, CNX Gas will develop a revised drill plan for the remaining project wells, beginning with those at the south well site.

Attachment A

Photographs of North Well Site, April 2003

Attachment B

Photographs of RR ROW and South Well Site, April 2003

Attachment C
Presentation delivered at DOE Second Annual Conference on Carbon Sequestration
May 5 – 8, 2003 - Alexandria, Virginia

Enhanced Coal Bed Methane (CBM) Recovery and CO_2 Sequestration in an Unmineable Coal Seam

Gary Cairns

CONSOL ENERGY

Research & Development
South Park, Pennsylvania

U. S. Department of Energy Cooperative Agreement No. DE-FC26-01NT41148

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About CONSOL Energy

- Coal mining operations dating back to 1864
- Current operations in PA, OH, WV, VA, KY, IL, and Australia
- Operates more longwall mining systems than any other US coal producer
- Largest exporter of coal in the US
- Expanding CBM operations in Virginia, Pennsylvania and West Virginia

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Project Background

- Carbon sequestration offers an approach to reduce CO_2 emissions and potentially stabilize future atmospheric CO_2 levels
- Unmineable coal seams may be attractive sequestration sinks for CO_2
- Coal bed methane is a powerful greenhouse gas. Its capture and use recovers a valuable fossil fuel resource
- Field research is required to evaluate the CO_2 adsorption capacity of coal and the economics of sequestration

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CONSOL's Background with CBM

- CONSOL is a major producer of CBM in central Appalachia (southwestern Virginia)
- In Virginia, CBM is recovered with horizontal wells, hydraulically fractured vertical wells, and gob wells
- The high strength geology surrounding the central Appalachia coals contains the fracture within the coal
- Hydrofracs propagate up to 500 feet in the coal seam

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CONSOL's Background with CBM

- Geology surrounding the coal seams in northern Appalachia is typically much weaker
- Hydraulic fracturing has proven to be less effective for CBM recovery in the Pittsburgh seam
- Hydrofracs are not contained and extend outside of the the coal seam

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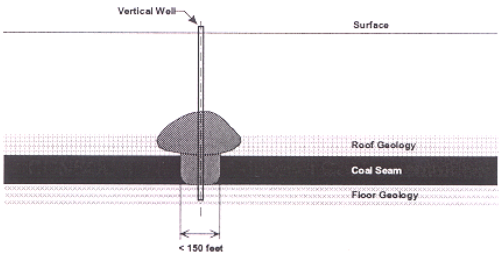
Unsuccessful Hydrofrac



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Benefits of Horizontal Drilling

- Does not require strong roof and floor strata to be effective
- Exploits a large areal extent of the coal reserve from a single surface location
- Improves mining productivity by degassing the mineable coal in advance
- Drilling wells from the surface that extend horizontally through the coal seam affords the greatest potential for optimizing both CBM recovery and CO_2 sequestration

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General Description of CONSOL Project

- Field program to evaluate CBM recovery and CO_2 sequestration in an unmineable coal seam
- Use directional drilling to develop a series of wells extending up to 3000 feet horizontally in two overlying coal seams
- Initially, recover CBM from both seams
- In time, inject CO_2 at centrally located wells in lower seam (unmineable)
- Recover CBM and monitor CO_2 concentrations at exterior wells (both seams)

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Advantages of this Approach

- Design allows recovery of CBM resource from both the mineable and unmineable coal seam
- CBM from the mineable seam is captured and utilized, rather than vented to the atmosphere upon mining
- Dual greenhouse-gas-reduction benefits:
  - Sequester CO_2 in the unmineable seam
  - Avoid methane emissions (a potent greenhouse gas) from the mineable seam

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Program Objectives

- Demonstrate horizontal drilling into coal seams
- Define effective CO_2 injection procedures
- Evaluate the CO_2 adsorption capacity of coal beds
- Measure the effects of CO_2 injection on CBM recovery
- Monitor the concentration of CO_2 in recovered CBM over an extended period of time
- Assess overall effectiveness and cost of CO_2 sequestration with this approach

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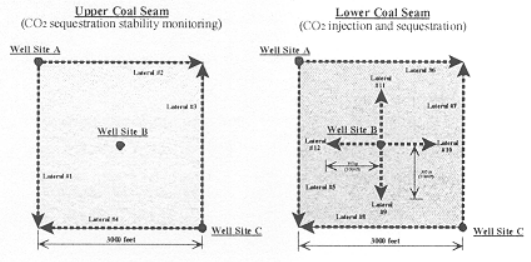
Plan View



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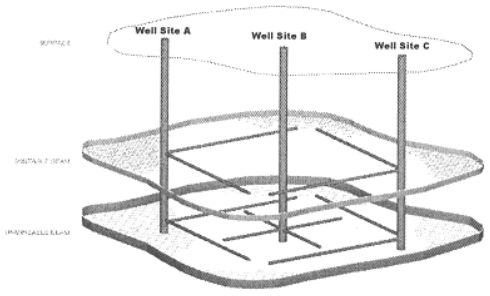
Conceptual View



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Monitoring

- CBM recovered from upper seam monitors vertical migration of CO_2
- CBM recovered from lower seam monitors horizontal migration of CO_2
- Project includes additional monitoring wells to further examine horizontal and vertical migration of CO_2

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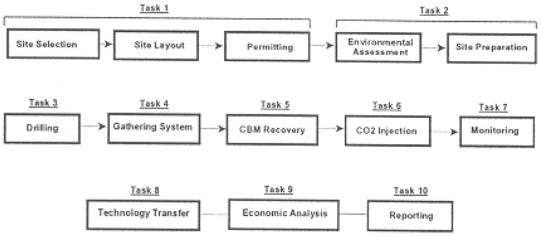
Project Tasks



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Progress to Date
Site Selection

- Evaluated geologic data obtained from seven exploratory core holes completed in northern West Virginia
- Assessed thickness and continuity of lower coal seams (beneath the Pittsburgh seam)
- The Upper Freeport seam was selected as the lower seam (unmineable) for the project for its seam thickness and uniformity
- A location in Marshall County, WV, was judged most favorable in terms of thickness of coal seams, accessibility, and topography

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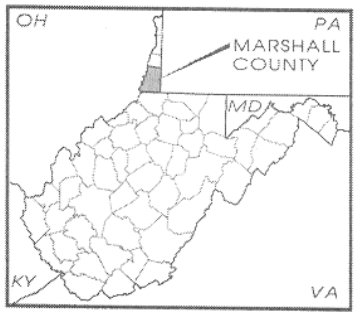
Project Location
Marshall County, West Virginia



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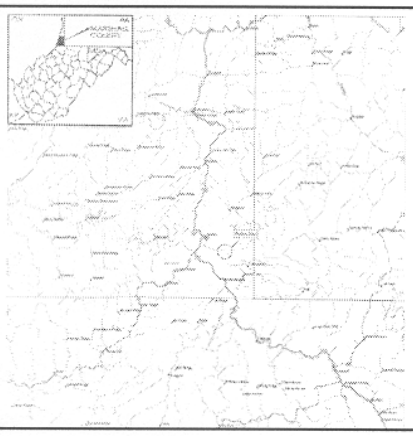

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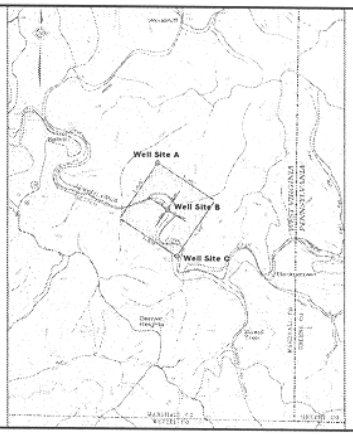

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Evaluation of Core Samples From Selected Site

Coal Seam	Seam Thickness (Feet)	Depth to Top of Seam (Feet)	Gas Content (Std. ft³/Ton)
Pittsburgh	6.72	669.40	136
Upper Freeport	4.25	1260.90	182

Gas contents are listed on a dry, ash free basis and include desorbed, residual and lost gases.

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Progress to Date
Permitting

- Identified all landowners and secured all surface and subsurface property rights necessary for the project
- Land use agreements, necessary for surface construction activity, were negotiated with three separate land owners
- Prepared and submitted well permit applications for the three well sites
- Well permits for the north corner location were approved in November 2002

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Progress to Date
Environmental Assessment

- An environmental assessment report describing the project and its potential environmental impacts was submitted to NETL
- Interacted with state and federal agencies as required
- Limited construction approval was issued in November 2002
- Final NEPA approval was granted in March 2003

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Progress to Date
Site Preparation

- Excavation work at the north corner of the project began in November 2002
- An access road to the north well site was constructed and site prep work was completed in December 2002
- Excavation work at the south corner commenced in March 2003 and was completed in April 2003

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Progress to Date
Drilling – North Corner Well Site

- A log was completed at the north corner site
  - Pittsburgh: 1,125' Deep, 7.5' Thick
  - Upper Freeport: 1,716' Deep, 5.0' Thick
- Two wells in the Pittsburgh seam were completed with 3,000' horizontal extensions
- Encountered a thinning coal seam while drilling the first well in the Upper Freeport seam. Well was completed with 2,200' of horizontal extension
- Final well in Upper Freeport seam to be completed later in 2003

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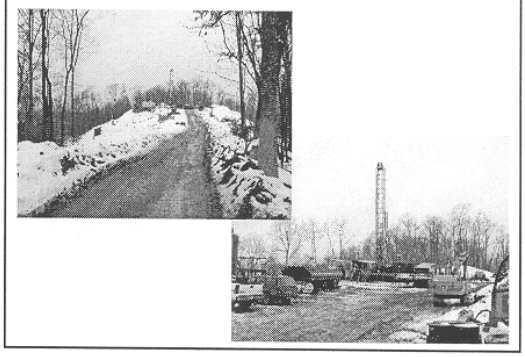
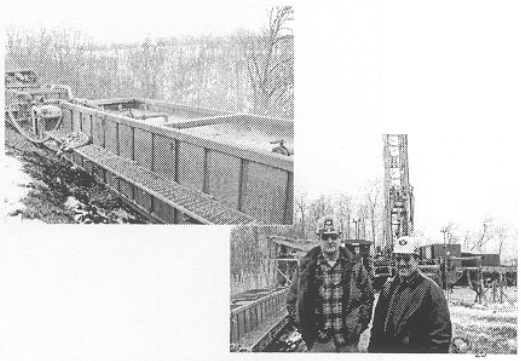
North Well Site, January 2003



North Well Site, January 2003



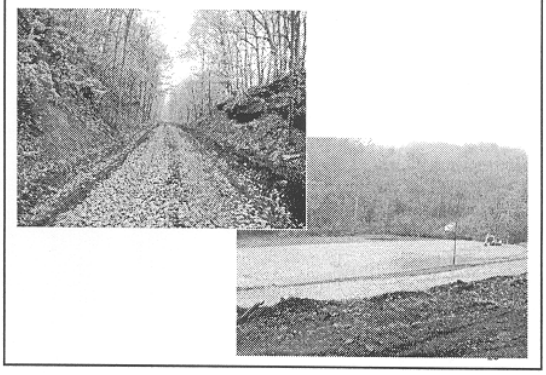
North Well Site, April 2003

South Well Site

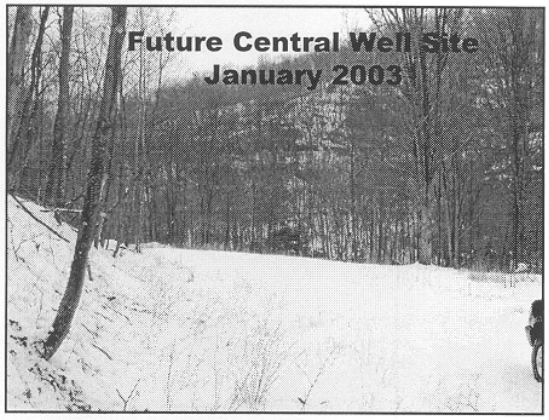
March 2003

January 2003

South Well Site, April 2003



Future Central Well Site January 2003



Future Work
Projected Timeline

- Complete Drilling: 3rd Quarter 2003
- CBM Recovery: 2004 - 2008
- Begin CO_2 Injection: 2005
- Stop CO_2 Injection: 2007
- CO_2 Monitoring: 2004 - 2008

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Acknowledgement

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