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

Semi-Annual Technical Progress Report
October 1, 2002 through March 31, 2003

Gary L. Cairns

April 2003

DOE Cooperative Agreement DE-FC26-01NT41148

CONSOL Energy Inc.
Research & Development
4000 Brownsville Road
South Park, PA 15129

DISCLAIMER

ABSTRACT

This is the third semi-annual Technical Progress report under the subject agreement. During this report period, substantial progress was made on finalizing NEPA approval, securing well permits for the project wells, developing the well sites, and 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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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 roughly 85 percent of the U.S. greenhouse gas emissions, and most of these emissions are CO_2 [1]. 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 coal bed 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 CBM produced, the program includes additional monitoring wells to further examine horizontal migration of CO_2 within the lower seam.

This is the third Technical Progress report for the project. Progress to date has been focused on pre-construction approvals and construction at two of the project well sites. 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 October 14 and January 7, as required. In November, CONSOL accepted the terms of the patent rights waiver for the cooperative agreement, as outlined by DOE patent counsel. CONSOL executed amendment M003, which revised Article 2.27 and provided limited approval to proceed with construction at the north well site. CONSOL hosted the DOE COR, and other DOE personnel, on a tour of the project well sites on January 31.

PROGRESS ON ENVIRONMENTAL ASSESSMENT (EA)

Throughout October, CONSOL interacted with NETL, the West Virginia Division of Culture and History (WVDCH), and the U. S. Fish and Wildlife Service as required to advance the EA. As a result, DOE issued a contract amendment in late October that granted NEPA approval, limited to the north corner location of the project. In November, at the request of the WVDCH, an archeological firm was contracted to complete a Phase I archeological survey of the two southern well locations. No historic or prehistoric findings were identified. On December 30, DOE released the EA draft for public review and comment. No comments on the EA draft were received during the review period, which closed on January 24. On March 10, NETL notified CONSOL that all NEPA requirements for the project had been satisfied; i.e., a Finding of No Significant Impact. Therefore, groundbreaking activities at the southern well sites could commence.

PROGRESS ON WELL PERMITS

Prior to commencing any drilling activity in West Virginia, including the construction of an access road to a well site, a well permit application must be prepared and approved by the West Virginia Department of Environmental Protection (WVDEP). In early November, well permits for the four wells that compose the north corner of the project were approved by WVDEP. Similarly, well permits for the four wells that compose the south corner were approved in January 2003. The drilling plan for the center wells was revised; approval of the revised well permits for that location is anticipated in May 2003.

CONSTRUCTION PROGRESS – NORTH WELL SITE

With NEPA and WVDEP approvals secured, excavation at the north corner well site began in early November. An access road, approximately one mile in length, was constructed from the existing township road to the designated north corner location of the project. Construction activity for the access road included some removal of timber and extensive earthwork. Similarly, substantial earthwork was required to prepare the well site in advance of drilling. In mid-December, site preparation work was completed and drilling contractors mobilized to the site.

The drill plan for this location included four horizontal wells, two in the Pittsburgh seam and two in the Upper Freeport (UF) seam. The wells in each seam are drilled at 90 degrees of separation to form two sides of a square. Initially, the vertical component of each of the four wells was completed, including the installation and cementing of the steel casing for each. While drilling the vertical component of the first well, a vertical

borehole extending below the UF seam was completed. This borehole was used to complete a natural gamma log and establish a datum for this location. The log revealed the Pittsburgh seam to be 1,125 feet deep and 7.5 feet thick, and the UF seam to be 1,716 feet deep and 5.0 feet thick. Upon completing the log, the borehole was plugged with cement.

All elements (vertical, curve, horizontal, and sump) of the two wells in the Pittsburgh seam were successfully drilled with 3,000 feet of horizontal extension, as originally planned.

While proceeding with the horizontal component of the first well in the UF seam, the drilling contractors determined that the seam thickness had thinned to less than eighteen inches. Consequently, drilling at this well was terminated after attaining approximately 2,200 feet of horizontal extension.

While drilling the curved component of the fourth well (in the UF seam), the drillers breached the coal seam at a depth shallower than expected. As a result, the angle of the curve had not yet reached horizontal, as desired. CNX Gas decided to proceed with casing the curve; however, the bottom of the casing was to be positioned approximately 30 feet above the coal. This distance was sufficient to allow drillers to continue the curve, on a redirected path, and land horizontally in the coal seam. After the casing was installed in the curve, a cement plug was required to fill the previously drilled hole and to aid drillers in redirecting the curve. During the process of installing the cement plug, a collar on the drill steel apparently became hung at the bottom of the casing, which prevented the drill rig from extracting the drill pipe from the hole. As this occurred, the newly poured cement was curing to the drill pipe. As a result, several hundred feet of drill steel were cured in the cement and lost down the hole. With these unforeseen setbacks and being uncertain of the best course of action, CNX Gas elected to postpone all drilling operations at this location on March 1. Drilling contractors will return to complete this well (or possibly start anew) later in 2003, after drilling has been completed at the south and central well sites of the project.

In late March, a contractor was hired to clear solids that had collected in the sumps of the three completed wells. It appears that cuttings generated while drilling the sump flowed into the horizontal well. Upon completion of drilling, these cuttings flowed back into the sump. This could have impeded the future installation of the pumps. CNX Gas expects all the pumps to be installed and operating in April.

CONSTRUCTION PROGRESS - SOUTH WELL SITE

NETL advised CONSOL of full NEPA approval for the project in early March; excavation work along the railroad right of way (RR ROW) and at the south well site began shortly thereafter. Consequently, the contractor that prepared the well permits for the project well sites was recalled to survey the length of the RR ROW.

CNX Gas purchased three trailers; one to serve as a field office, and two as living quarters for the drilling contractors. The trailers will be situated on the property between

the ROW and the well site. Electrical service has been established at the site to power the trailers and equipment associated with the drilling mud. Site preparation work is progressing. Recent photographs of the south well site are included in this report as Attachment A. Vertical drilling is projected to commence in late April. Initially, CNX Gas plans to drill only two wells at the south well site. The wells and sumps will be completed and assessed prior to advancing with the next set of wells. This schedule will allow for additional adjustments to the drilling approach, if deemed necessary.

PROGRESS - CENTRAL WELL SITES

The design of the project wells, developed by CNX Gas, varies significantly from the originally proposed design. As such, it was necessary to alter the arrangement of the wells at the center of the project. A revised arrangement that closely matches the original layout was developed and is shown in Figure 1. The new configuration consists of two independent wells that originate along the RR ROW and are separated by approximately 850 feet. Each well will include a curved section and two diverging horizontal laterals extending 1,000 feet each into the coal. Both wells will breach the UF coal seam at approximately the geometric center of the project. This design will provide a reduction in drilling costs, while expanding CO_2 injection options. Permit applications for the central well sites reflecting the revised layout were prepared and submitted to WVDEP. Site preparation work for these wells will begin following permit approvals.

PROGRESS ON PUBLIC COMMUNICATIONS

A presentation titled "Enhanced Coal Bed Methane (CBM) Recovery and CO_2 Sequestration in an Unmineable Coal Seam" (Attachment B) was prepared and delivered at the Second International Forum on Geologic Sequestration of CO_2 in Deep, Unmineable Coalseams, March 6 – 7, 2003, in Washington, D. C. A draft version of the presentation was submitted to the DOE COR and Patent Counsel.

An abstract of the same title (Attachment C) was prepared for DOE's Second Annual Conference on Carbon Sequestration, May 5 – 8, 2003, in Alexandria, Virginia. The abstract was submitted to the DOE COR and Patent Counsel.

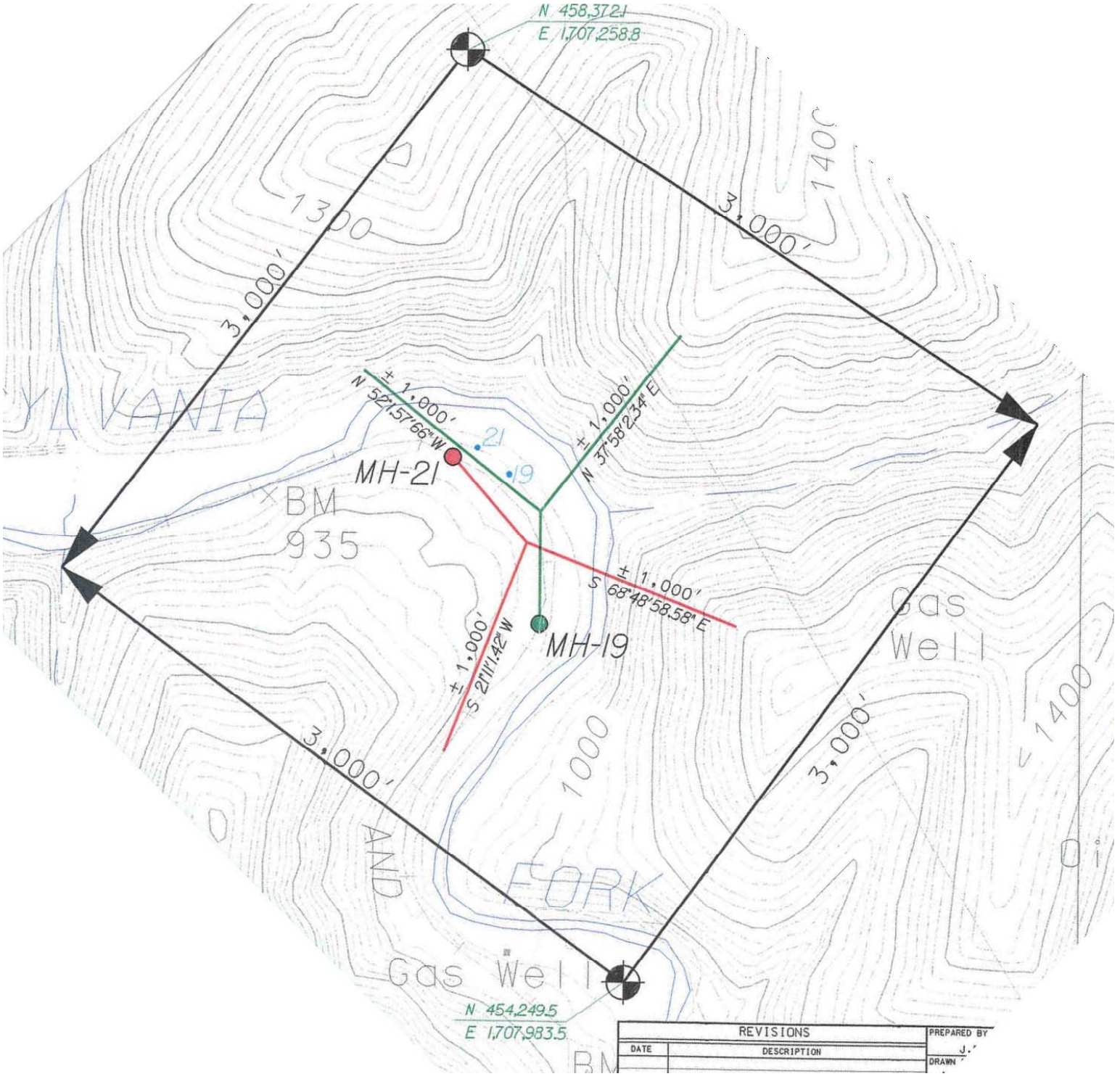
CONCLUSION

All pre-construction approvals were secured for the north and south project well sites. Construction is underway and expected to continue at all three project well sites through October 2003. Numerous drilling challenges were confronted at the north well site. In order to prevent these problems on future wells, CNX Gas plans to refine the drilling procedures and adjust the drilling schedule for the remaining project wells.

REFERENCES

(1) U.S. Environmental Protection Agency, **2000** *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1998*, EPA 236-R-00-001, April 2000.

Figure 1. Revised Layout – Central Well Sites



Attachment A

Photographs of South Well Site, March 2003

Attachment B

Prepared for Presentation at the
Second International Forum on Geologic Sequestration of CO_2 in Deep, Unmineable Coalseams (Coal-Seq II)
March 6 – 7, 2003
Washington, D. C.

Gary Cairns
CONSOL Energy Inc.
Research and Development
4000 Brownsville Road
South Park, PA 15129

Phone: (412) 854-6640
Fax: (412) 854-6613
garycairns@consolenergy.com

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

About CONSOL Energy

- Coal mining operations dating back to 1864
- Current operations in PA, OH, WV, VA, KY, IL, and Australia
- Operates most longwall mining systems in the US
- 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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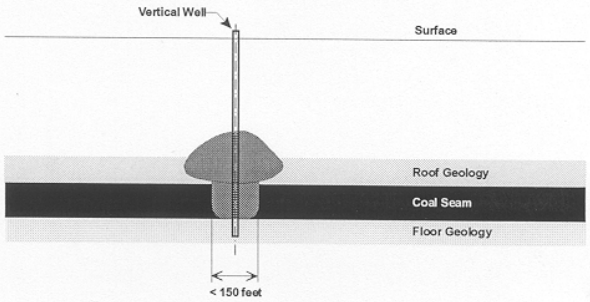
Unsuccessful Hydrofrac



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Benefits of Horizontal Drilling

- Does not require a favorable geology to be effective
- Exploits a large areal extent of the coal reserve from a single surface location
- Potentially more cost effective approach
- 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 underground coal seams
- Define effective CO_2 injection procedures
- Evaluate the CO_2 adsorption capacity of seam coal
- 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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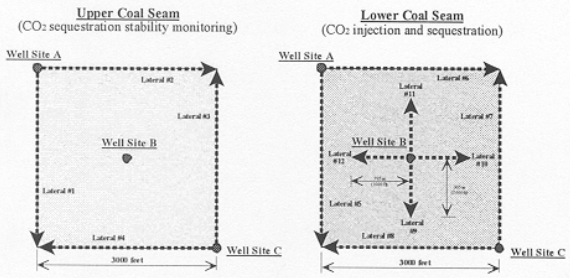
Plan View



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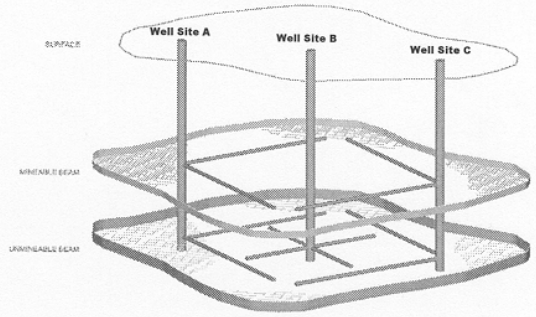
Conceptual View



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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 wells to further monitor horizontal and vertical migration of CO_2

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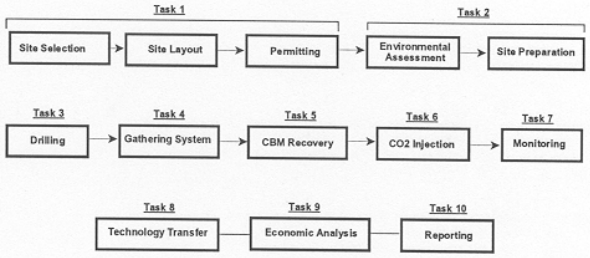
Project Tasks



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Progress to Date
Site Selection

- Evaluated geologic data obtained from seven exploratory core holes recently 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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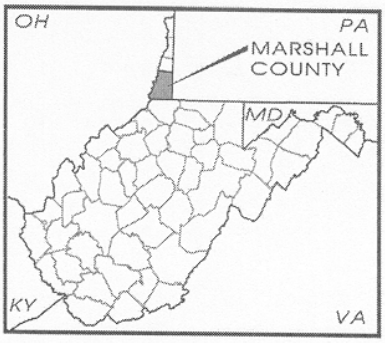
Project Location
Marshall County, West Virginia



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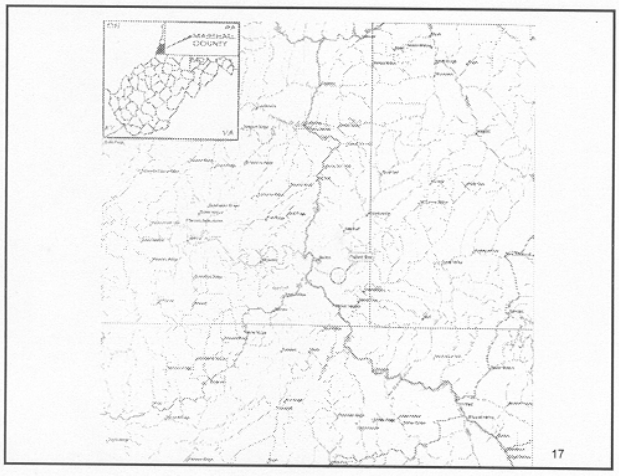

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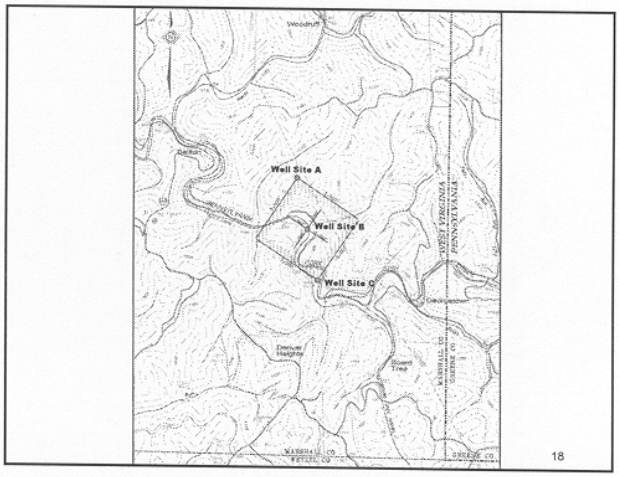

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Evaluation of Core Samples From Selected Site

Coal Seam	Seam Thickness (Feet)	Depth to Top of Seam (Feet)	Gas Content (ft^3/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 is anticipated this month

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Progress to Date
Site Preparation

- Excavation work at the north corner of the project began in November 2002
- Access road construction and well site prep work were completed in December 2002
- Drilling began at the north corner in December 2002

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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

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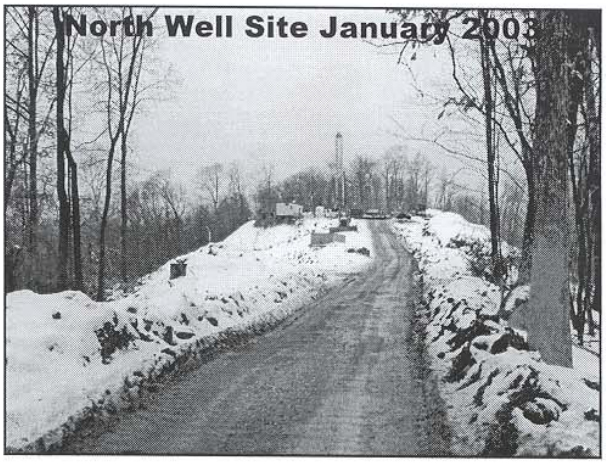
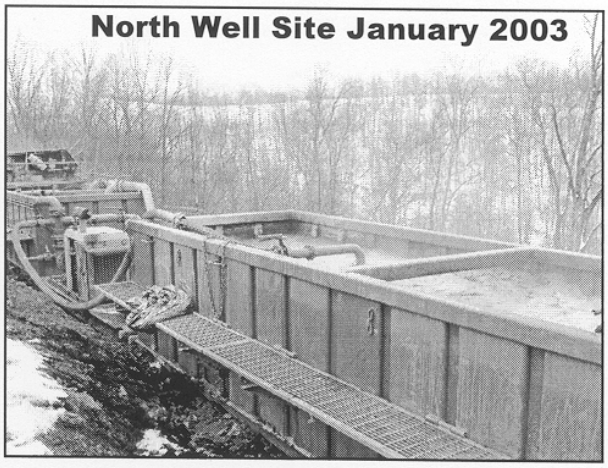
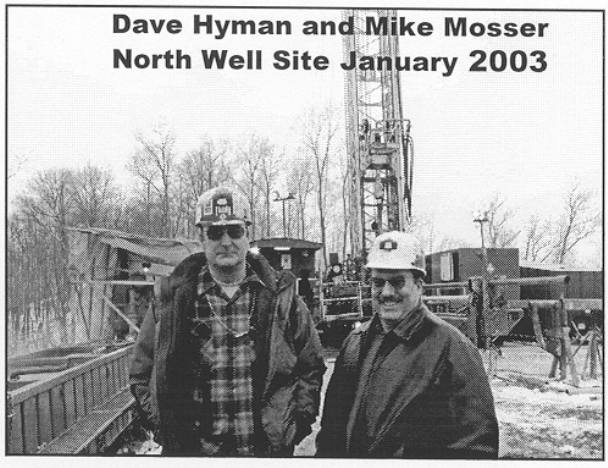
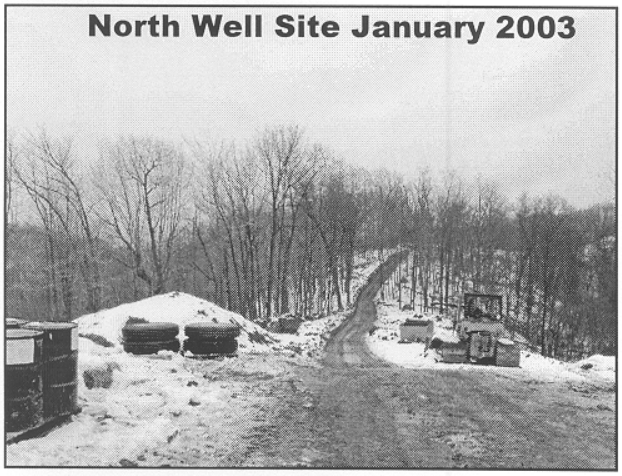


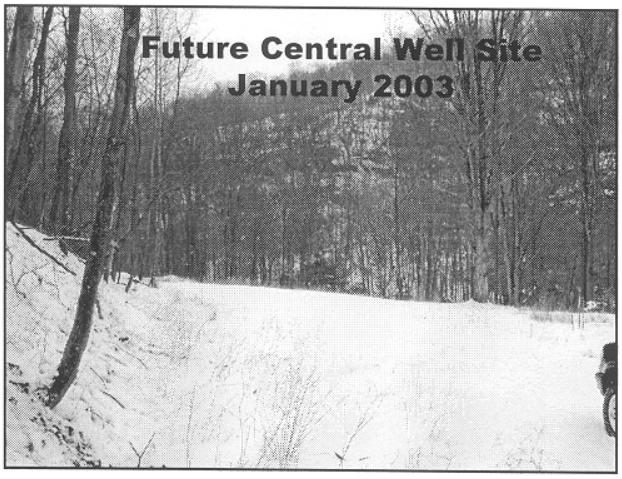

North Well Site January 2003

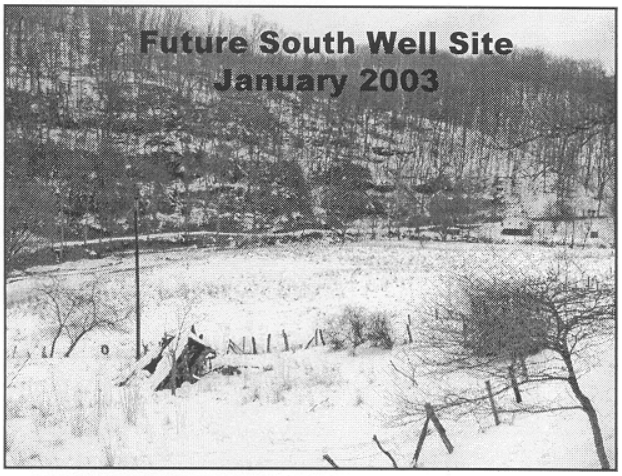

North Well Site January 2003


North Well Site January 2003


Dave Hyman and Mike Mosser
North Well Site January 2003







Future Work
Projected Timeline

- Complete Drilling: 3rd Quarter 2003
- CBM Recovery: 2004 - 2008
- Begin CO_2 Injection: 4th Quarter 2004
- Stop CO_2 Injection: 3rd Quarter 2006
- CO_2 Monitoring: 2004 - 2008

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Acknowledgement

- U.S. Department of Energy, National Energy Technology Laboratory, Cooperative Agreement No. DE-FC26-01NT41148
  - David Hyman and Lloyd Lorenzi
- CNX Gas Company LLC
  - Joe Aman
- CNX Land Resources Inc.
  - Esther Smoke

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Attachment C

Abstract prepared for
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

Presented by:
Gary Cairns
Research Engineer

CONSOL Energy Inc.
Research and Development
4000 Brownsville Road
South Park, PA 15129
Phone: (412) 854-6640
Fax: (412) 854-6613
garycairns@consolenergy.com

This abstract was prepared with the support of the U. S. Department of Energy, under Award No. DE-FC26-01NT41148, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not reflect the views of the DOE.

ABSTRACT

CONSOL Energy, with funding from DOE, has begun field construction on a seven-year project to evaluate both CBM recovery and CO_2 adsorption capacity of an unmineable coal seam. The project will demonstrate the application of a series of wells, drilled from the surface and extending up to 3000 feet horizontally, to drain CBM from an unmineable coal seam in the Appalachian basin. In time, some of the wells will be used for CO_2 injection/sequestration, which will further enhance CBM recovery. This approach offers CBM recovery and CO_2 sequestration over a large areal extent of the reserve from one surface location.