



EERC

EERC Technology... Putting Research into Practice

The Plains CO₂ Reduction (PCOR) Partnership

Phase II Activities

May 9, 2007



PCOR Partnership

Phase II Goals

- Increase public understanding of CO₂ sequestration
- Perform field validation tests that develop:
 - Monitoring, mitigation, and verification (MMV) protocols.
 - Regional sequestration strategies.
 - Best separation/source matches.
 - Regulatory and permitting strategies.
 - Environmental benefits and risks.
 - Information needed to monetize C credits.
- Continued regional characterization.
- Creating a vision for practical environmentally sound carbon management strategies.

The PCOR Partnership involves more than 60 partners who represent public agencies, utilities, oil and gas companies, engineering firms, associations and nonprofit organizations, and universities.



PCOR Partnership Phase II – Regional Field Verification Activities



Williston Basin Oil Field



- CO₂ in a deep oil reservoir – CO₂ will be injected into an oil-bearing zone.
- We are currently finalizing plans with Hess Corporation for this summer's field-based activities.
- Sharing Eclipse models and expertise.

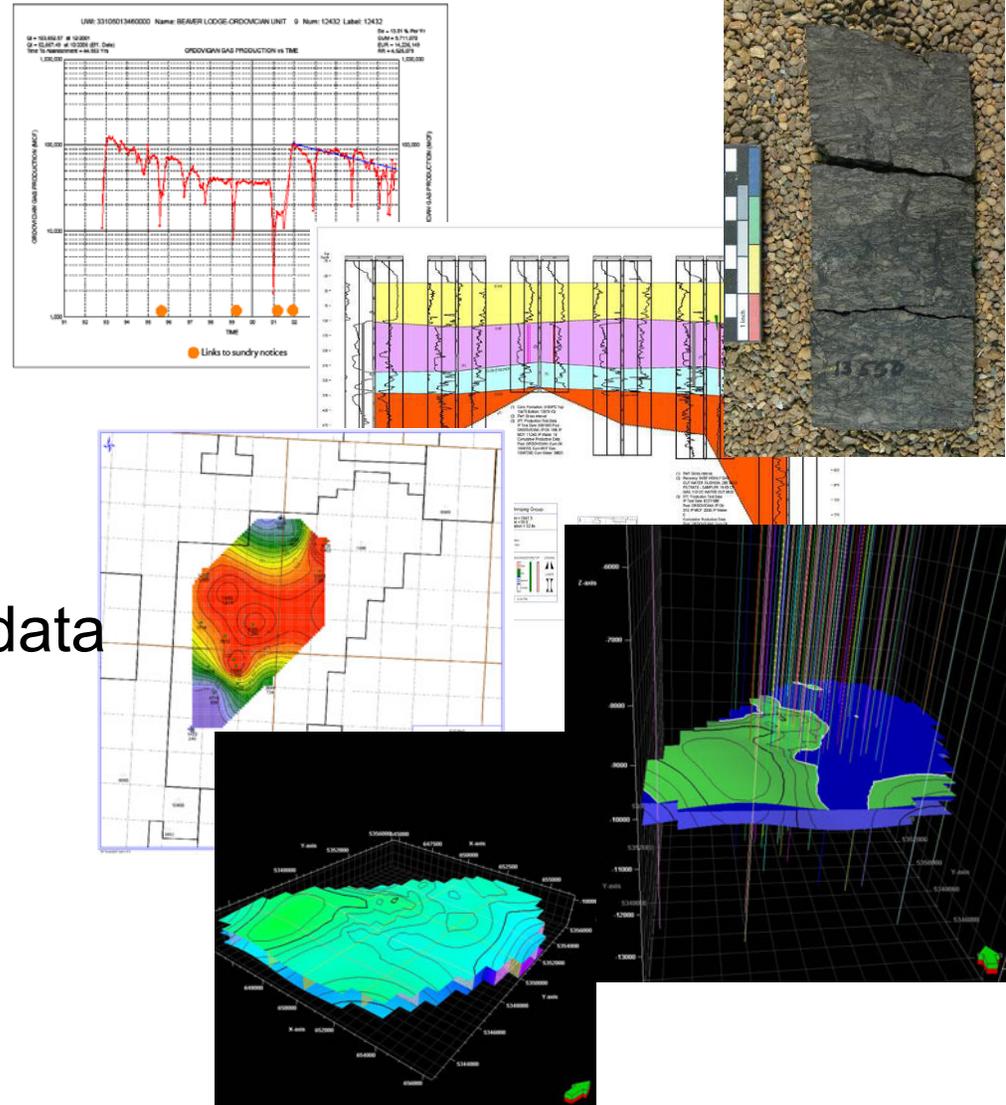
Williston Basin Demonstration

- Target formations include:
 - Devonian Duperow.
 - Ordovician Winnipeg.
 - Cambrian Deadwood.
- Year 2 focused on developing baseline characterization data for these formations.

ERA	AGE OF FORMATION		CENTRAL WILLISTON BASIN
CENOZOIC	Tertiary	Pliocene	Flaxville
		Miocene	
		Oligocene	White River
		Eocene	Golden Valley Sentinel Butte
		Paleocene	Tongue River
MESOZOIC	Cretaceous	Upper	Mont. Group
			Hell Creek Fox Hills
		Middle	Colo. Group
	Niobrara Carlile Greenhorn Belle Fourche Mowry		
	Lower	Dakota Group	Newcastle / Skull Creek
			Dakota Fuson Lakota
	Tri. Jurassic		Morrison
			Ellis Group
			Swift Riedon Piper
			Spearfish
PALEOZOIC	Permian	Ochoa	
		Guadalupe	
		Leonard	
		Wolfcamp	
	Penn.	Virgil	
		Missouri	
		Des Moines	
		Atoka	
		Morrow	
		Chester	
	Miss.		Amnsden
			Charles
			Mission Canyon
			Lodgepole
	Devonian	Upper	Bakken
			Three Forks
			Nisku Duperow Souris River Dawson Bay
	Sil.	Middle	Prairie Winneposis Ashern
			Interlake
	Ord.	Richmond Beckmantown	Guntion
Stony Mountain Red River Winnipeg			
Camb.	Upper		
		Deadwood	
		Pre-Cambrian	

Williston Basin Baseline Characterization

- Core analyses
- Well log analyses
 - Digitization
 - Maps and cross sections
- Injection and production data
- Reservoir modeling



Zama Acid Gas EOR Project



- One of four Alberta demonstration projects to receive royalty credits for injecting CO₂ for enhanced oil recovery (EOR).
- Approach combines acid gas disposal and CO₂ EOR.
- Potential to expand to over 600 additional pinnacles.



Zama Field Validation Test

- Injection started December 2006
- Injecting approximately 90 tons of acid gas per day
- Sequestration of 25,000 tons (375 MMcf) of CO₂ per year
- Incremental production increase of 10%–15% of original oil in place (OOIP)



Lignite Field Validation Test

- Determine the accuracy with which CO₂ storage capacity in lignite coal can be predicted.
- Develop data regarding the potential of CBM to be produced from lignite coal as a by-product of CO₂ injection.
- Demonstrate cost-effective MMV technologies and protocols for:
 - CO₂ sequestration.
 - Enhanced coalbed methane (CBM) in a lignite coal seam.



Lignite CBM Research Project Burke County, ND

Section 36, T. 159 N., R. 90 W.

~ Proposed access route

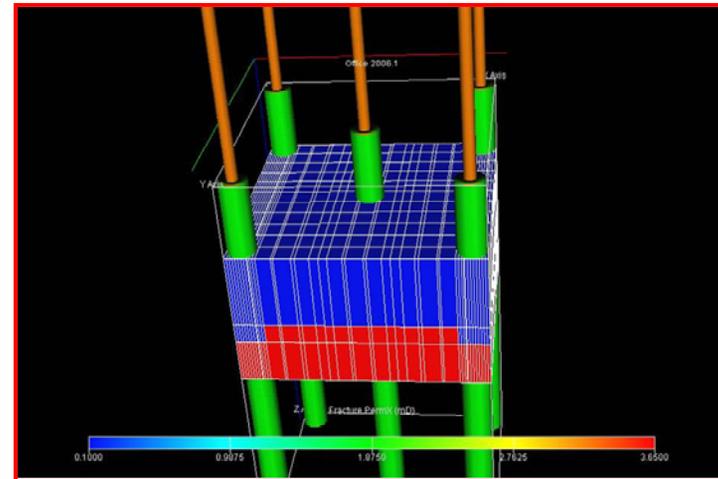
- Drill and complete 4 monitoring wells
- Complete an existing well for CO₂ injection



Location Map

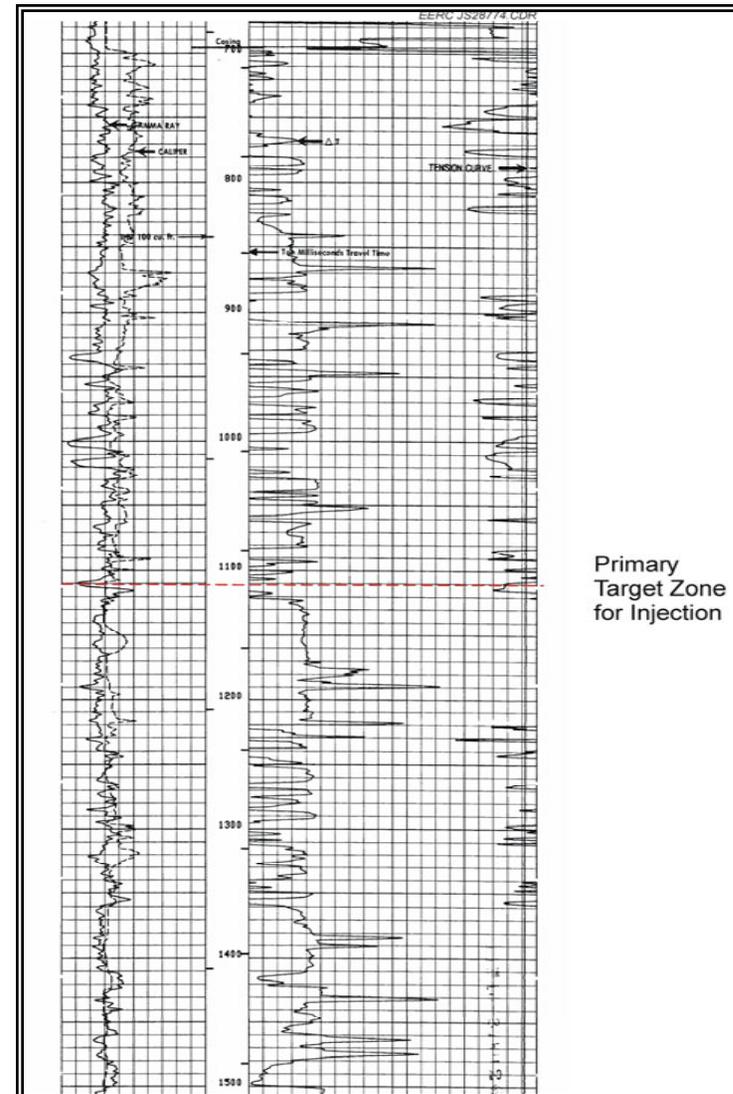
Testing Program

- Baseline data collection
 - Analyze available logs in vicinity of test site
- Create numeric model (Eclipse)
- ***Formation logging***
- ***Core studies***
- Anticipated field tests
 - Pump test
 - Microfrac test
 - Leak-off test



Formation Logging

- Gamma ray
- Sonic
- Resistivity
- Density
- Mud logging or elemental capture spectroscopy
- Multiarm caliper
- Acoustical



Core Studies

- Gas content
- Gas specific gravity
- CH₄ and CO₂ isotherms
- Diffusion coefficient
- Gas desorption time
- Coal ash and moisture contents
- Coal density and compressibility
- Rock porosity and permeability



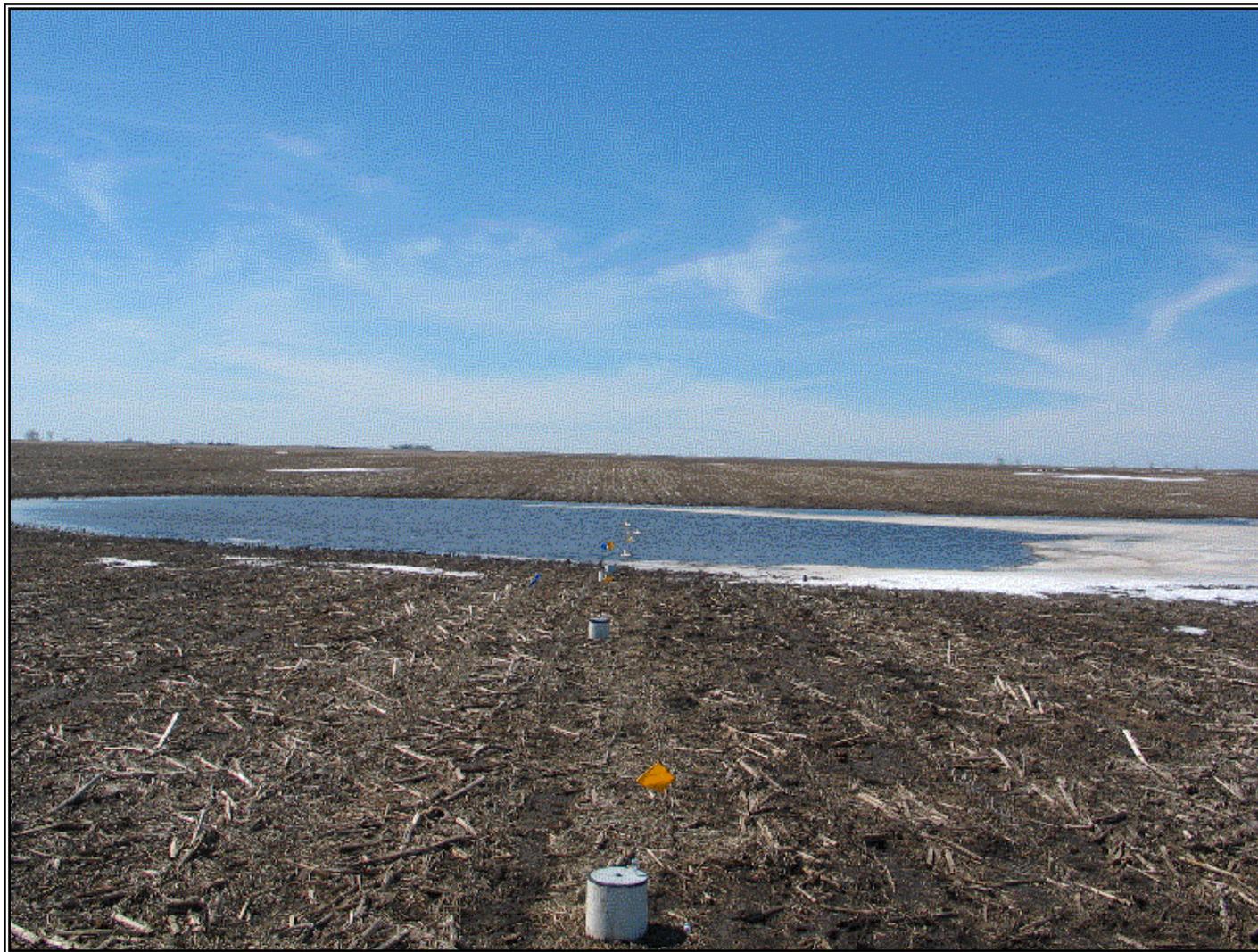
Lignite Field Validation

Test Next Steps

- Plan to drill and begin dewatering process by the end of Summer '07.
- Use acquired log data and in situ monitoring data to validate numerical model.
- Begin modeling CO₂ fate using validated model.
- Begin CO₂ injection.



PCOR Partnership Wetland Field Validation Test



Task 5 – Terrestrial Field Validation Test

Highlights of Progress to Date

Soil Sampling

– 2006 soil sampling complete

- Soil sampling on Sheridan County, North Dakota, sites complete. The samples have been milled and are currently being analyzed.

–2007 soil sampling (initiate May 2007)

- Three sampling areas have been selected for the 2007 field season (SD and MN). One 40-acre restoration will be a monoculture of switchgrass to evaluate its ability to sequester carbon when grown to produce biomass for ethanol production.

Wetland Catchment Sampling (started March 2007)

- 17 wetland catchments will be sampled in north central South Dakota.

- To eliminate background variation among sites, wetland catchments selected were similar with respect to water regime, size, land-use history, and soils. Emissions of greenhouse gases (GHGs) (i.e., CO₂, CH₄, N₂O) will be measured biweekly throughout the growing season.

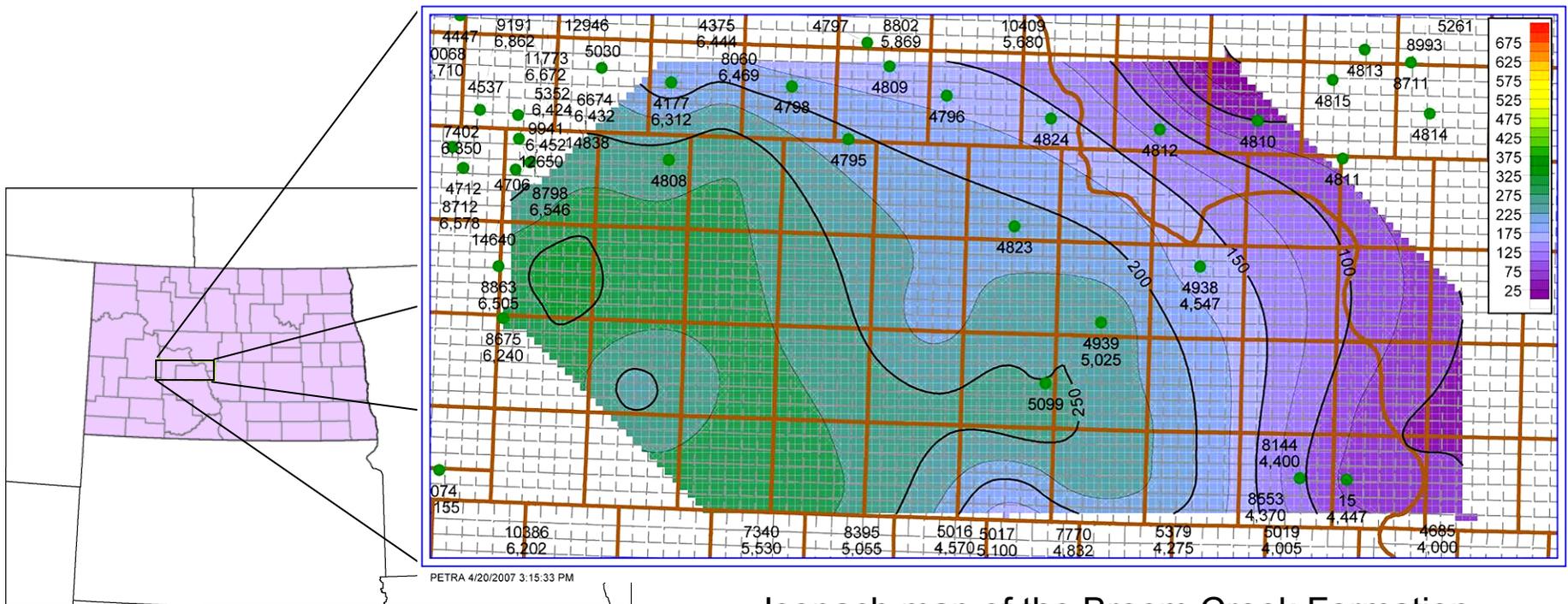
Task 5 – Terrestrial Field Validation Test (cont.)

Additional Products

- **Best management practices fact sheet**
 - This information provides the basis for management plans that will be incorporated into carbon sequestration easement documents.
- **Indirect benefits fact sheet**
 - Other economic and environmental incentives that may result from agricultural land restoration, such as water quality, erosion control, flood buffering, and recreational and wildlife benefits have been identified.
- **Business flow processes fact sheet**
 - Processes are being defined using a number of scenarios in light of recent market interest and activity, policy developments and trading guidelines, and the types of terrestrial carbon offsets being traded. Business flow processes include:
 - Prospectus for grassland carbon offset sale in the Prairie Pothole Region (PPR) (complete).
 - General term sheet for grassland carbon offset sale with investor in the PPR (complete).
 - Carbon sequestration fact sheet for investors (complete).
 - Evaluation of DOE guidelines for aggregators and terrestrial offset providers (review complete, and document in draft form).
 - Evaluation of other state and regional GHG or cap-and-trade programs – rules and policies (in process).
 - Private carbon/easement legal document (complete).
 - Landowner Agreements (draft).
 - Legal document to transfer carbon rights from landowner for an aggregated transaction (draft)
- **Business requirements document (draft)**
 - This document defines all of the aspects of information tracking that are required for a carbon transaction, including financial agreements, habitat, carbon monitoring, third-party verification, risk management, insurance, etc.

Focused Characterization Efforts

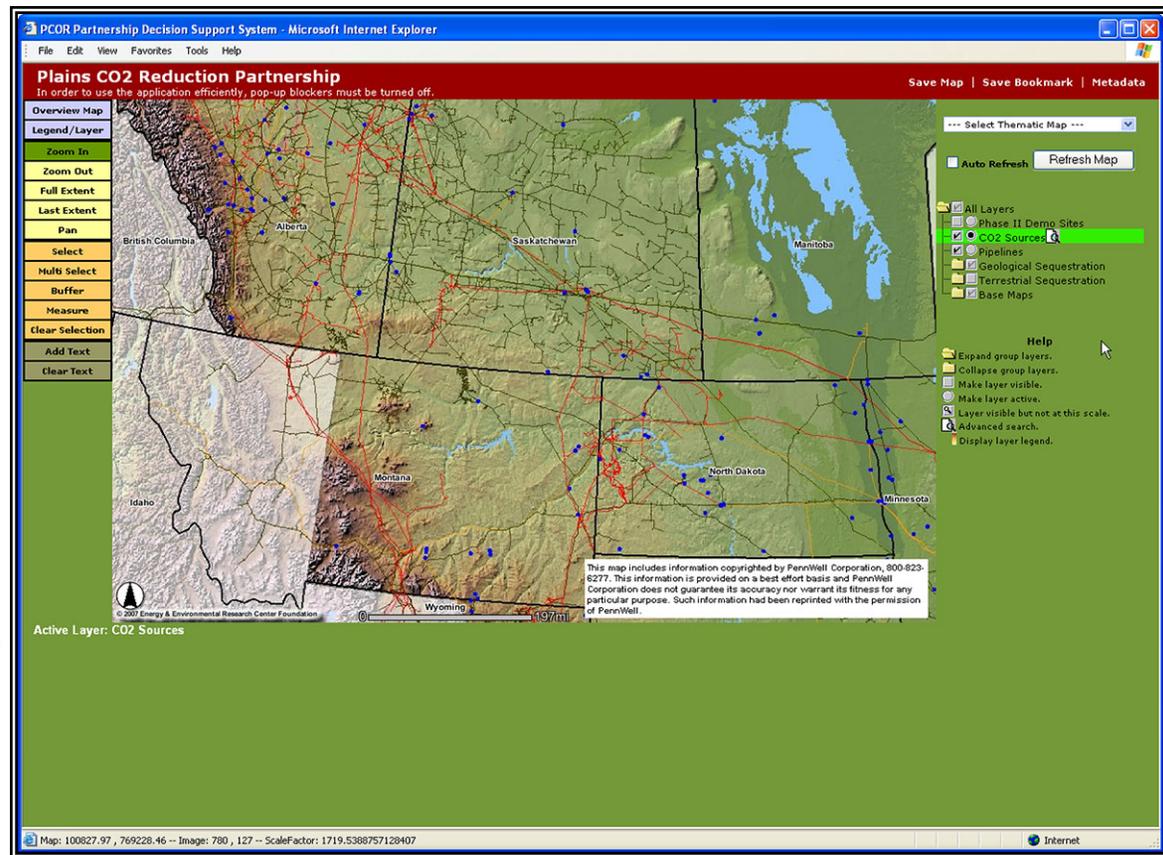
- More detailed evaluation of the CO₂ sequestration potential of saline formations in central North Dakota



Isopach map of the Broom Creek Formation

Enhancement to the DSS

- Pipeline distribution system added showing routes and commodities.

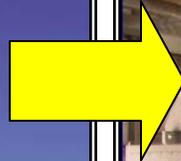


Task 7 – Research Safety, Regulatory, and Permitting Issues

- Interstate Oil and Gas Compact Commission (IOGCC)
 - Carbon Capture and Geological Storage Regulatory Task Force
 - Developing model regulations dealing with site licensing, well operation, well/site closure, and long-term storage.
 - Legal Subgroup
 - Technical Subgroups
 - » Site Licensing and Well Operations
 - » Well/Site Closure and Long-Term Storage



Capture, Separation, and Transportation Technologies Task **Applicability of Wind Power to Sequestration Scenarios**



A Best Practices Manual was prepared explaining how to determine if wind power could offset some of the electricity needs in a particular CO₂ sequestration scenario. Using the guidelines, it was shown that 18 wind turbines could provide power for two of the 19,500-hp CO₂ compressors at the Dakota Gasification Company's Great Plains Synfuels Plant.

Capture, Separation, and Transportation Technologies Task

A Carbon Management Plan is being prepared for the planned Excelsior Energy integrated gasification combined cycle (IGCC) facility. The plan will include:

- Overview of CO₂ capture technologies, dehydration, and compression
- Pipeline transportation
- Geologic sequestration options
- Terrestrial sequestration options
- Environmental and commercial risks
- Carbon markets
- Economic estimates
- Conclusions/recommendations





For more information on the PCOR Partnership please contact:

Ed Steadman
(701) 777-5279
esteadman@undeerc.org

John Harju
(701) 777-5157
jharju@undeerc.org