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Energy & Environmental Research Center (EERC)

CARBON CAPTURE, UTILIZATION, AND SEQUESTRATION: OVERVIEW OF NORTH DAKOTA CCUS

John "Jocko" Evans Symposium Butte, Montana

April 12, 2024

Timothy Shenk Senior Operations Specialist

CRITICAL CHALLENGES. PRACTICAL SOLUTIONS.

Energy & Environmental Research Center

The EERC is a leader in developing new technologies and practical solutions to critical energy challenges.

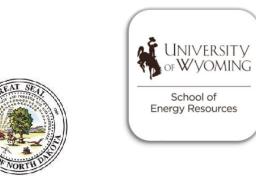
PLAINS CO₂ REDUCTION (PCOR) PARTNERSHIP

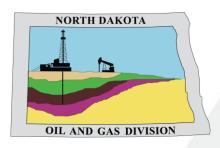
Led by the EERC. Funded by:

- U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL)
- North Dakota Industrial Commission (NDIC) Oil and Gas Research Program
- NDIC Lignite Research Program
- More than 240 public and private partners
 Partnered with:
- University of Wyoming
- University of Alaska Fairbanks









Industrial Commission of North Dakota Lignite Research, Development and Marketing Program



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Active and Developing **CCUS Projects in the PCOR Partnership Region**

- **Active Capture**
- Active Injection
- **Developing Capture**
- **Developing Injection** CO₂ Pipeline
- Proposed CO₂ Pipeline

Quest Boundary Dam EOR Fields for ACTL Weyburn Aquistore Great Plains Synfuels Plant Garbon Vault Cerilon & Roughrider Red Trail Energy **Coal Creek Station** Prairie Horizon Blue Flint Ethanol Snowy River Milton R. Young Station Summit. Lost Cabin Dry Fork Riley Ridge Station Shute Creek -**Tallgrass** Sweetwater Hub Gerald **Project Phoenix** Gentleman EOR Fields in Wyoming

Summit

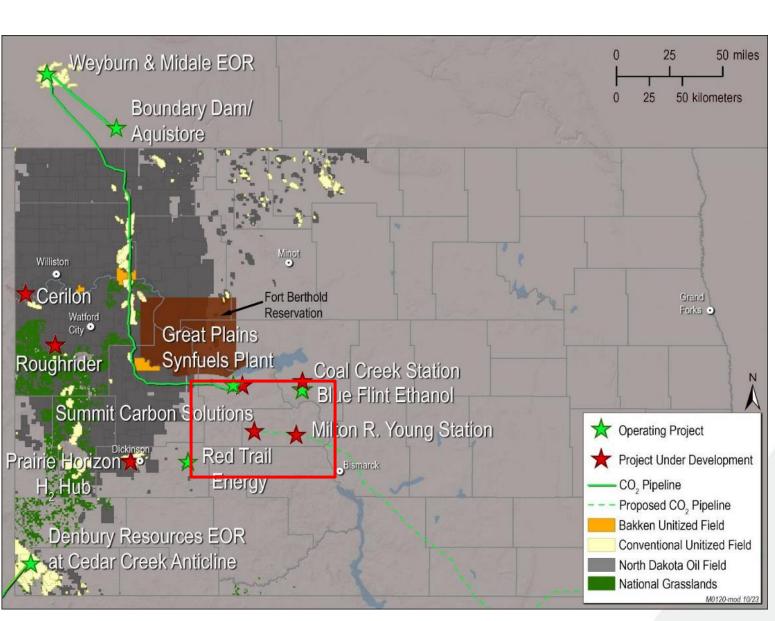
ACTL Nutrien

and Sturgeon

NORTH DAKOTA PROJECTS

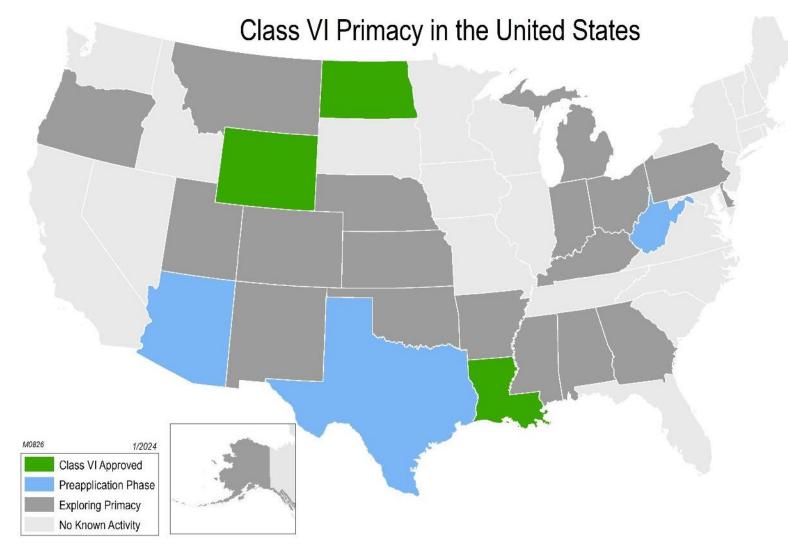
- EERC has been involved in multiple CCUS projects.
 - Two Class VI projects are actively injecting.
 - Storage facility permits (SFPs):
 - Six approved SFPs
 - Three SFPs under review
 - 11 stratigraphic test wells
 - Over 8000 ft of core

NORTH DAKOTA



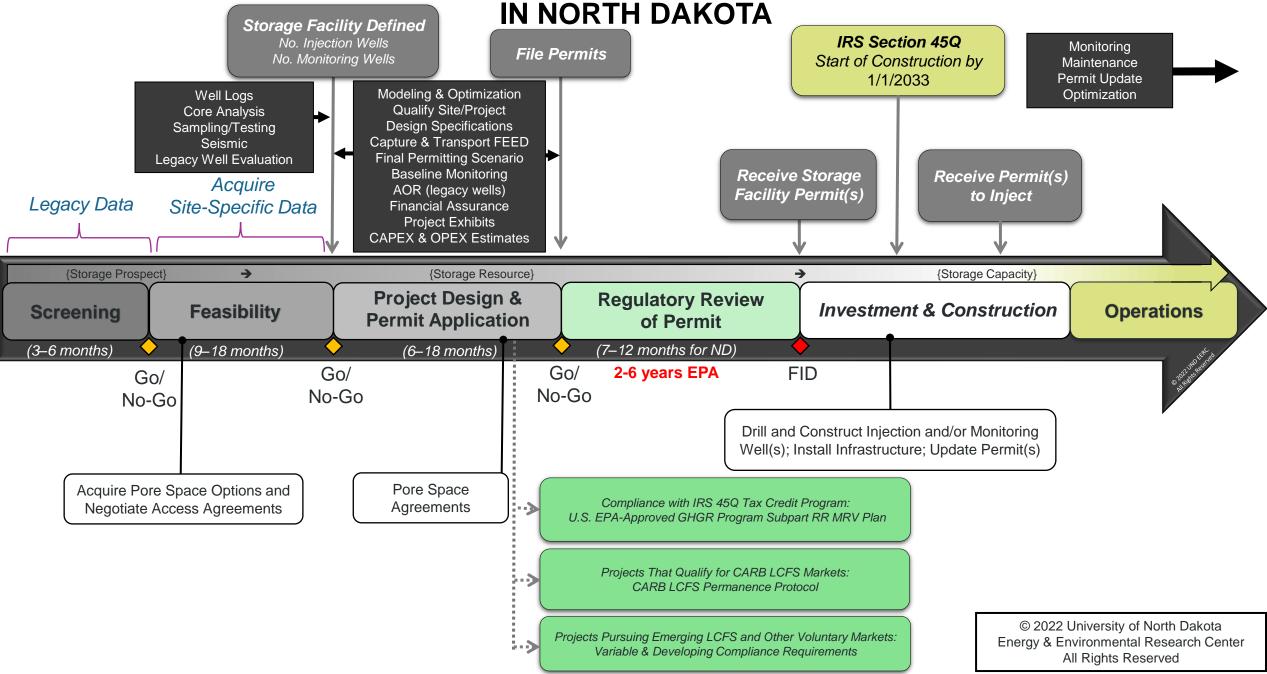
U.S. REGULATORY AUTHORITY

- U.S. Environmental Protection Agency (EPA)
 - 2010: Class VI Rule geologic sequestration wells
- U.S. states awarded primary regulatory authority:
 - 2018 North Dakota
 - 2020 Wyoming
 - 2023 Louisiana



Class I	Class II	Class III	Class IV	Class V	Class VI
Hazardous and nonhazardous fluids (industrial and municipal wastes).	Brines and other fluids associated with oil and gas production, including CO ₂ EOR.	Fluids associated with solution mining of minerals.	Hazardous or radioactive wastes. This class is banned by EPA.	Nonhazardous fluids into or above a USDW and are typically shallow.	Injection of CO ₂ for long-term storage.

TIMELINE TO IMPLEMENT CARBON CAPTURE AND GEOLOGIC CO₂ STORAGE



U.S. INCENTIVES

Internal Revenue Code § 45Q Tax Credits*

- Qualifying projects beginning construction before January 1, 2033, can claim credits for 12 years after operations begin.
- Direct payment option for receiving the credit (restrictions apply).
- Transferability of all or a portion of the credit value to any thirdparty, tax-paying entity in exchange for cash value during 12-year credit window.
- Tax credit for CO₂ stored in a qualified EOR project (\$60/tonne).
- Tax credit for CO₂ stored in a saline formation (\$85/tonne).

West Coast LCFS⁺ Markets

- Credits trading up to \$73/tonne (July 17, 2023)
- Stacked with 45Q

State Incentives

• State tax (e.g., no sales tax on capture-related infrastructure)



PREFEASIBILITY SITE-SCREENING WORKFLOW

STAGE 1

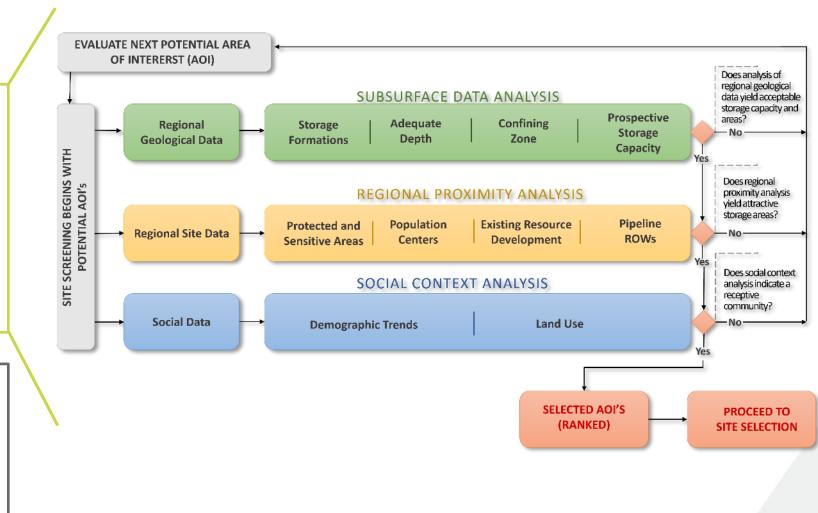
Site Screening and Ranking

- Screen potential sites and eliminate those that do not meet qualifying criteria.
- Perform static storage resource volume estimation for each site.
- Score and rank potential sites using surface and subsurface criteria.
- Generate a qualitative pros and cons list for each site.

STAGE 2

Site Characterization

- Determine most suitable top-ranking site from Stage 1.
- Evaluate need for a feasibility screening for selected top-ranking site.
 - Drill stratigraphic test wells, acquire site characterization and seismic data, lab testing, modeling, and simulations.

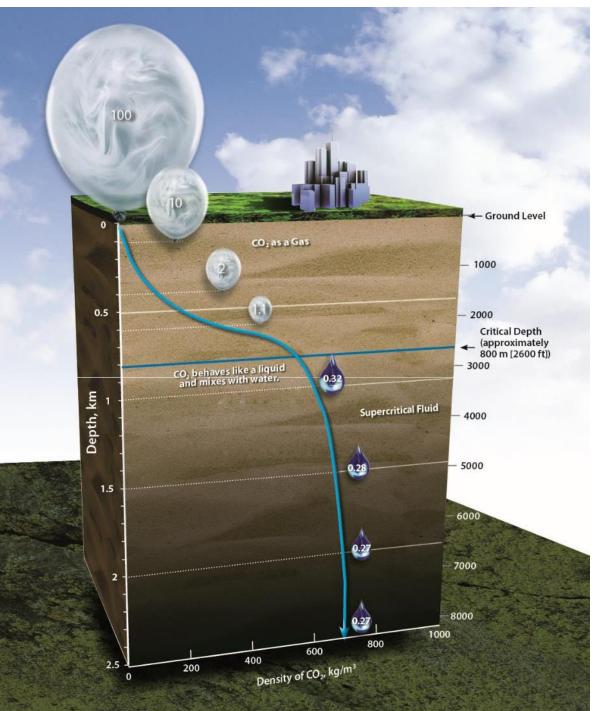


SCREENING CRITERIA FOR GEOLOGIC CO₂ SEQUESTRATION

- Depth >2600 ft
- Porosity sufficient for desired stored CO₂ volume
- Permeability sufficient to receive injected CO₂ at the rate required
- Effective sealing formations
- Salinity greater than 10,000 mg/L TDS

Depth

- Temperature and pressure conditions at depths greater than 2600 ft are effective in keeping CO₂ in the supercritical state:
 - Supercritical CO₂ has a density of liquid.
 - Does not have surface tension like liquid.
 - High density of supercritical CO₂ yields the most efficient use of subsurface storage space.

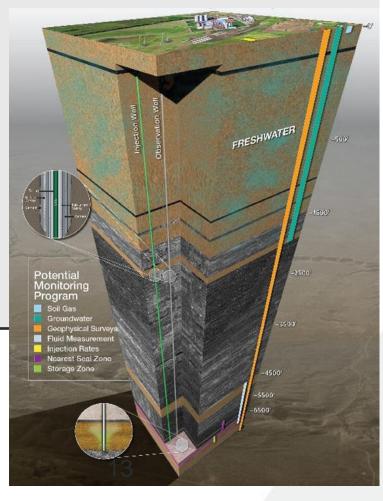


NORTH DAKOTA CO₂ SFP [CLASS VI] SECTIONS

- □ Pore Space Access
- Geologic Exhibits
- □ Geologic Model Construction and Numerical Simulation of CO₂ Injection
- Area of Review
- **Testing and Monitoring Plan**
- Postinjection Site Care and Facility Closure Plan
- Emergency and Remedial Response Plan
- U Worker Safety Plan
- Well Casing and Cementing Program
- Plugging Plan
- **M** Injection Well and Storage Operations
- □ Financial Assurance and Demonstration Plan
- Permit Appendixes

SFPs consist of 12 sections and are approximately 400+ pages in length.





FORMATION EVALUATION, **SAMPLING, AND TESTING**

Table 1. Recommended Suite of Well Logs for UIC Class VI Wells							
Surface Section							
OH ¹ /CH ²	Log						
OH	Triple combo (resistivity, density, porosity, GR ³ , caliper, and SP)						
OH	Acoustic compression and shear (dipole sonic)						
CH	CCL ⁴ -ultrasonic log-VDL ⁵ -GR-temperature log						
OH/CH	Long-String Section						
OH	Triple combo (resistivity, density, porosity,						
	GR, caliper, and SP (if using conductive mud); GR run to surface (0')						
OH	NMR						
OH	Spectral GR						
OH	Capture spectroscopy						
OH	Dipole sonic log (compression and shear waves)						
OH	Acoustic, electric, or optical borehole imaging						
OH	Fluid sampling						
OH	Formation pressure testing						
OH	Stress testing						
OH	Sidewall cores (as a backup option if whole core fails)						
CH	CCL-ultrasonic log-VDL-GR-temperature log						
¹ Openhole.							

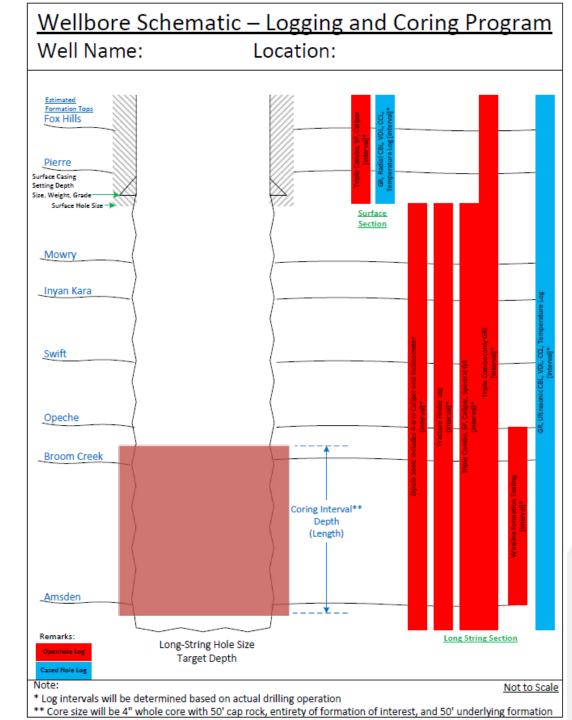
Cased hole.

Gamma ray.

Casing-collar locator.

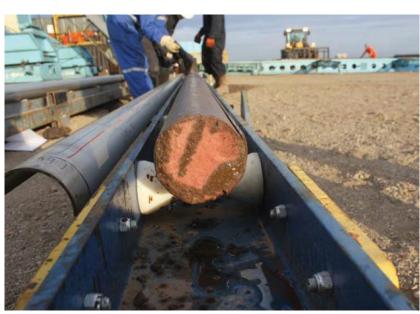
⁵ Variable-density log: ultrasonic log for radial cement bond.





CORING





Core Testing and Interpretation

- Routine analyses to identify the bulk characteristics of the formations including:
 - Lithology, thickness, porosity, permeability, and mineralogy.
 - Geomechanical competency of the overlying and underlying sealing formations.



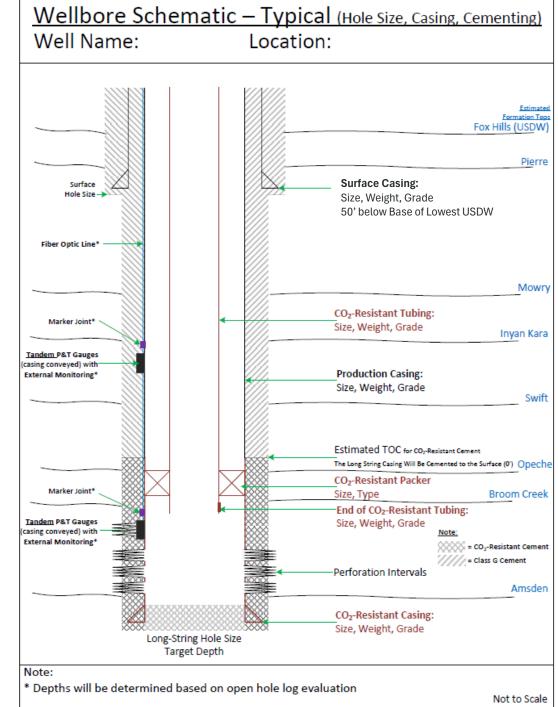




WELL CONSTRUCTION REQUIREMENT

NORTH DAKOTA.

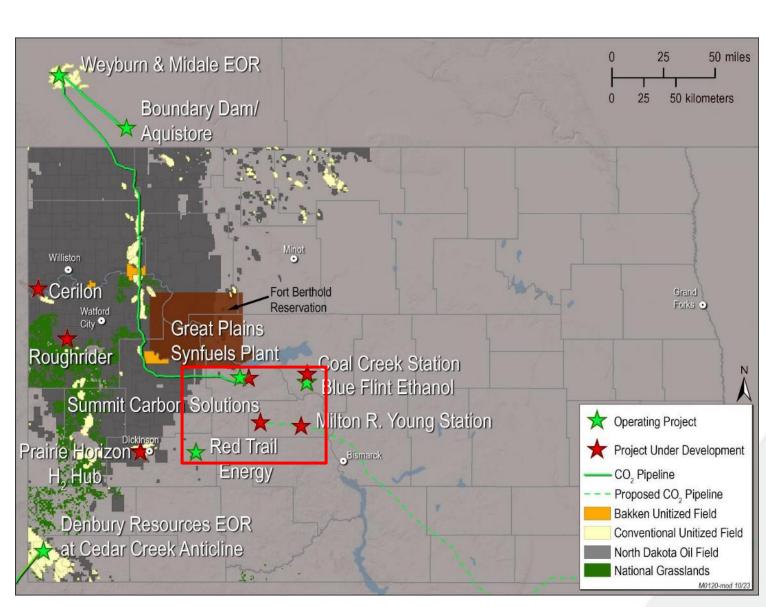
- Compliance and transition to underground injection control (UIC) Class VI injection or monitoring well.
 - CO₂-resistant material for tubulars and cement
 - Cement to surface in every hole section
 - Logging, testing, and monitoring tools for wellbore integrity and injection
 - Fiber-optic distributed acoustic, and temperature sensing; downhole P/T gauges



NORTH DAKOTA PROJECTS

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THANK YOU!

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