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Critical Challenges. Practical Solutions.



Energy & Environmental Research Center (EERC)

PERSPECTIVES FROM RECENTLY PERMITTED ONSHORE CCS PROJECTS

U.S. Department of Energy
Carbon Management Project Review Meeting

Pittsburgh, Pennsylvania
Wednesday, August 17, 2022

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PARTNERSHIP MEMBERS



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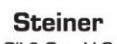


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FIRST WAVE OF INCENTIVE-DRIVEN CCS PROJECTS IN NORTH DAKOTA



GREAT PLAINS CO₂ SEQUESTRATION PROJECT

FACILITY Lignite coal gasification plant capable of gasifying 6 MMtpa

TONNAGE 1.0 to 2.7 MMtpa of CO₂

INJECTOR DESIGN Up to six injection wells into a single storage reservoir

REGULATORY STATUS

NDIC| March 2022: Class VI permit submitted

OTHER Within the anticipated CO₂ plume boundary area, 56% of the land surface is reclaimed mining land, creating unique conditions for near-surface and geophysical monitoring techniques.



SUMMIT CARBON SOLUTIONS

FACILITY 32 ethanol plants and other facilities in five states

TONNAGE 8.0 million tonnes per annum (MMtpa) of CO₂; initial pipeline capacity of 12.0 MMtpa, expansion capabilities to handle up to 20.0 MMtpa

INJECTOR DESIGN Multiple injection wells into stacked storage reservoirs

PROJECT STATUS Site characterization and design under way to inform Class VI permits and incentive program compliance

OTHER Largest proposed CCS project to date, one of the first CO₂ storage hubs



COAL CREEK STATION

FACILITY 1100-MW two-unit minemouth lignite coal-fired power generation facilities

TONNAGE About 9 MMtpa of CO₂ anticipated

PROJECT STATUS CO₂ capture pre-FEED study completed on one of the 550-MW units, FEED study under way.

OTHER Largest coal-fired power plant in North Dakota



MIDWEST AGENCY

FACILITY Blue Flint 70-million-gallon dry mill ethanol production plant

TONNAGE About 200,000 tpa of CO₂

INJECTOR DESIGN One CO₂ injector into single storage reservoir

PROJECT STATUS Stratigraphic test well and 3D seismic survey completed, modeling, design, and permitting under way

PROJECT TUNDRA

FACILITY 734-MW two-unit minemouth lignite coal-fired power plant

TONNAGE About 3.9 MMtpa of CO₂

INJECTOR DESIGN Dual injection wells into stacked storage reservoirs

REGULATORY STATUS

NDIC| January 2022: Two Class VI permits approved

EPA| December 2021: MRP plan submitted

OTHER CarbonSAFE Phase III North Dakota project



RED TRAIL ENERGY

FACILITY 64-million-gallon dry mill ethanol production plant

TONNAGE 180,000 tpa of CO₂

INJECTOR DESIGN One CO₂ injector into single storage reservoir

REGULATORY STATUS

NDIC| October 2021: Class VI permit approved
March 2022: Permit to inject approved

OTHER The DOE, the NDIC Renewable Energy Program, and the PCOR Partnership, provided funding for storage site development and demonstration of novel monitoring techniques.



¹Since 2003, the PCOR Partnership with its 200+ current and prior member organizations has been laying the groundwork for permanent, safe, and practical geologic storage of CO₂.

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CO₂ Point Sources

- Ethanol Production
- Coal-Fired Power Generation
- Gasification
- Fertilizer Production
- Natural Gas Processing
- Natural Gas Power Generation
- Industrial Processes

Capture/Storage Models

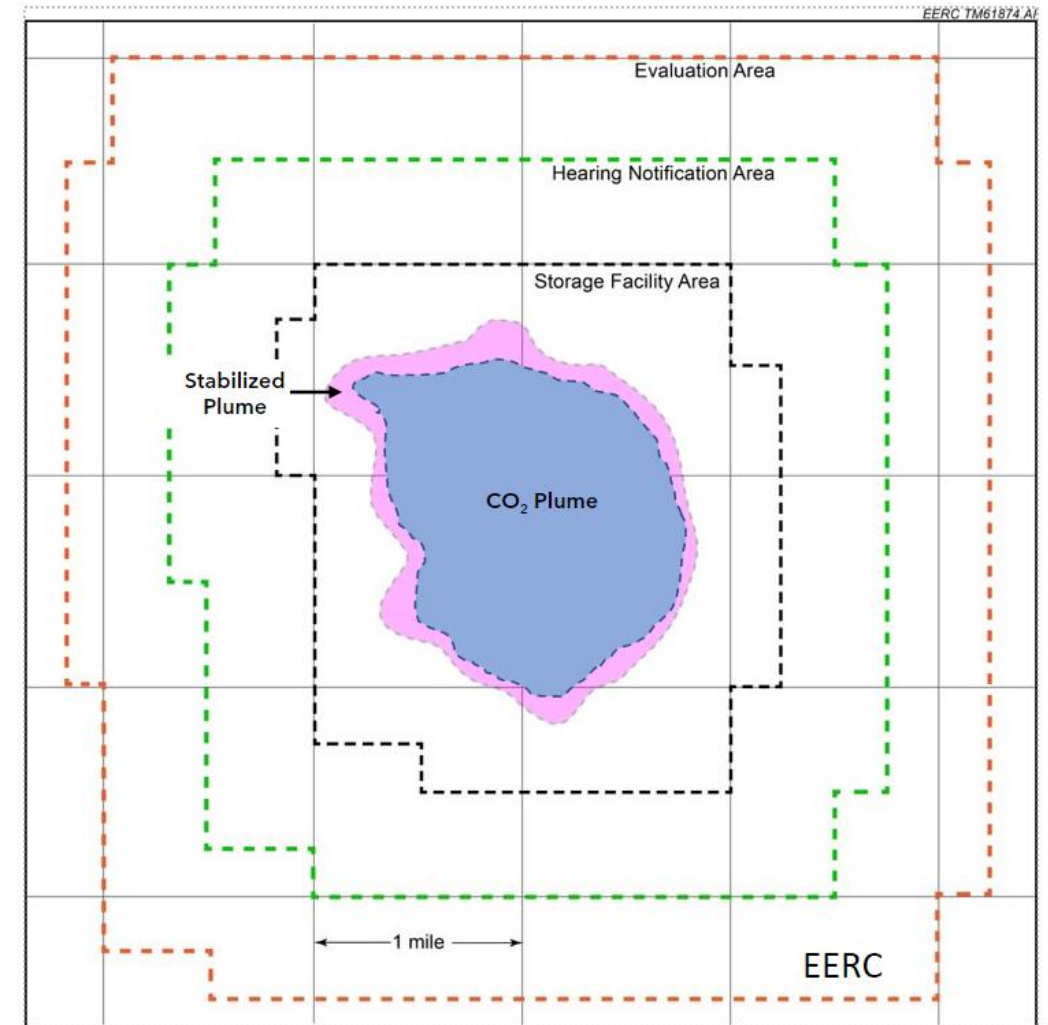
- Source/Sink-Matched
- Source Aggregation and Storage Hub
- Capture Hub with Distributed Storage
- Hybrid storage with Enhanced Oil Recovery, Minerals Recovery and/or other Utilization

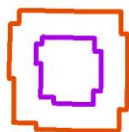
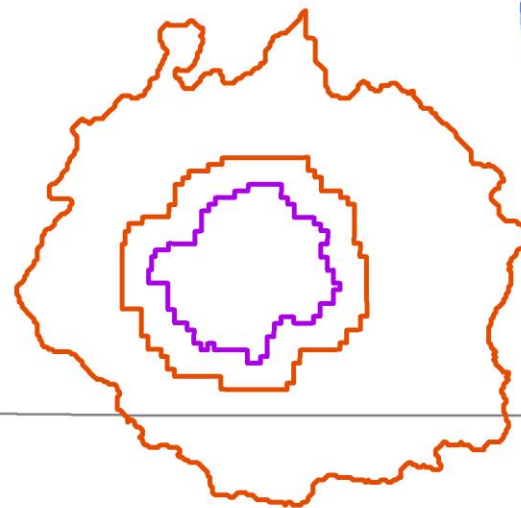
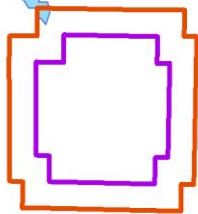
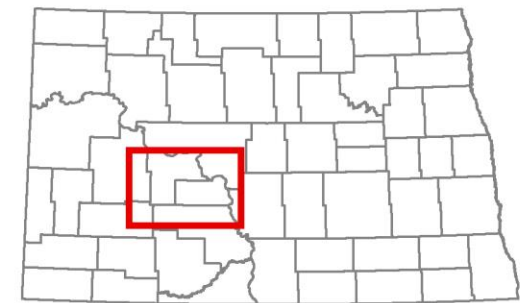
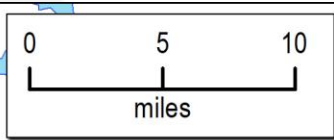
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STORAGE FACILITY PROJECT BOUNDARIES

North Dakota UIC Class VI

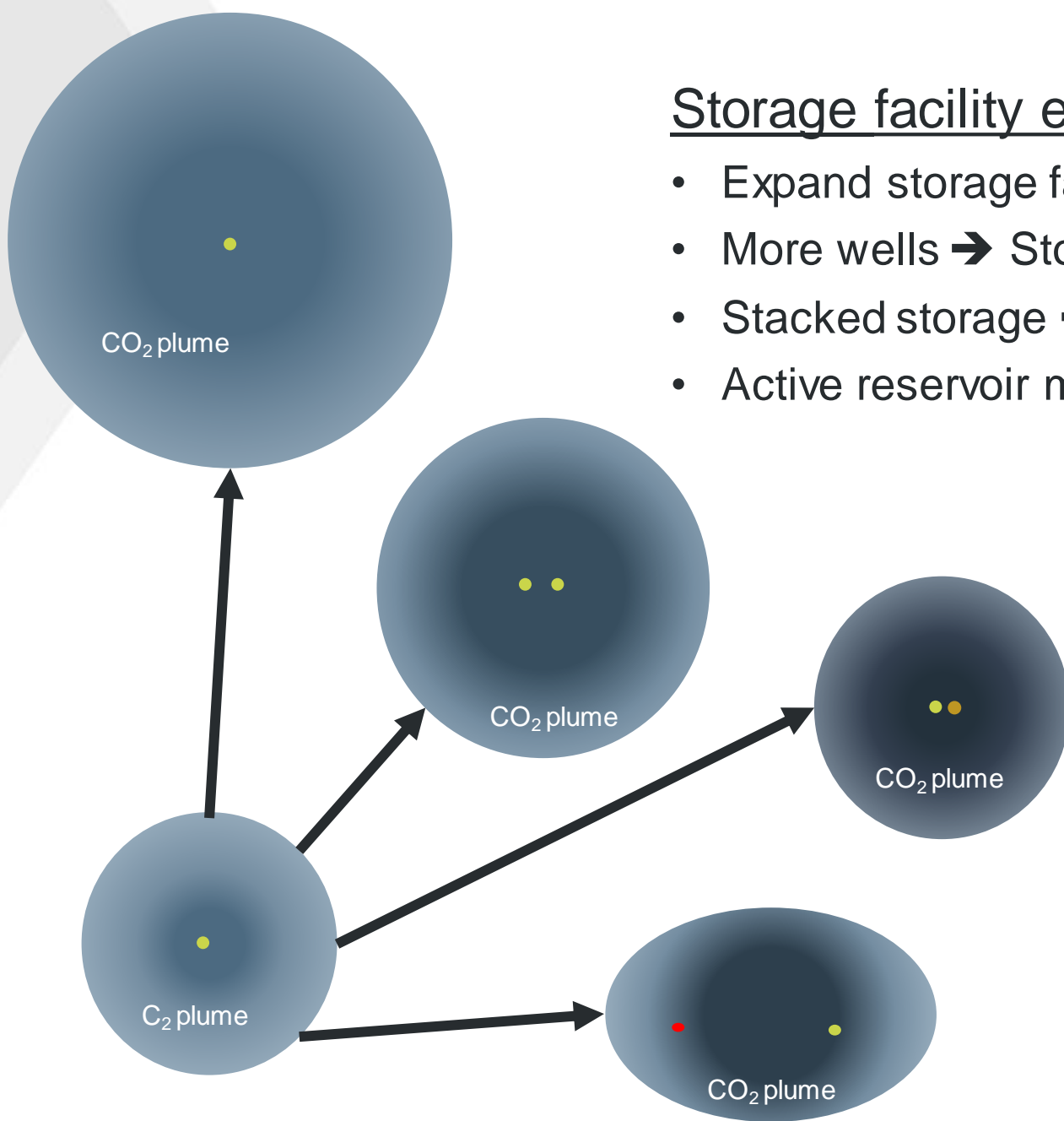
- **CO₂ Plume** – Simulated boundary at end of injection.
- **Stabilized Plume** – Simulated boundary at post-injection stabilization.
- **Storage Facility Area** – Boundary + Buffer
[Pore Space Lease and Amalgamation Area]
- **Hearing Notification Area** – ½ mile from the storage facility area boundary (mineral estate and surface estate).
- **Area of Review (AOR)** – Not shown; calculated with simulation.
- **Evaluation Area** – 1 mile from the storage facility area boundary (default minimum AOR).



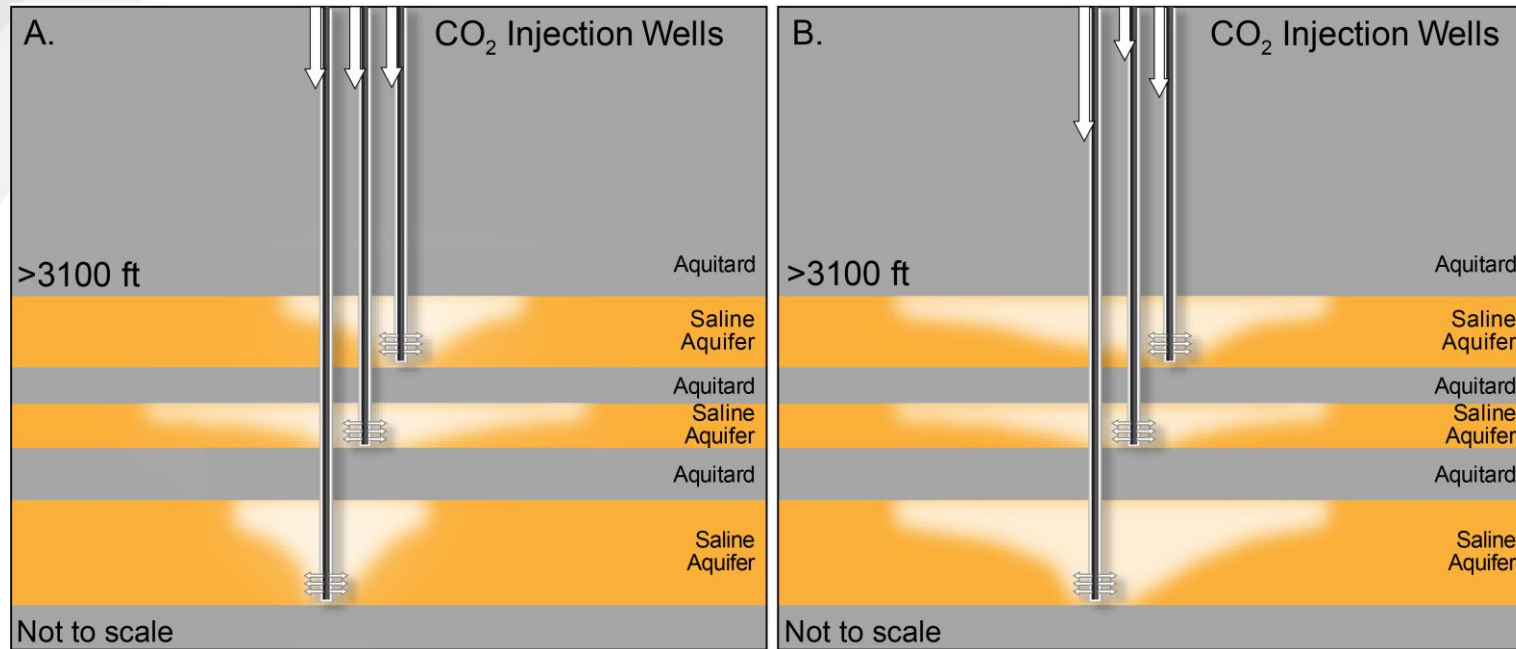


Storage facility expansion to accommodate additional CO₂

- Expand storage facility area → More capacity
- More wells → Storage efficiency → More capacity
- Stacked storage → More capacity
- Active reservoir management → Storage efficiency → More capacity



STACKED STORAGE



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Conceptual Scenario

Complex geology, lower capacity, and moderate development cost

Simple geology, great capacity, and low development cost

Moderate geology, moderate capacity, and high development cost

Great capacity, simple geology, and high development cost



ACTIVE RESERVOIR MANAGEMENT

Active Reservoir Management

- Mitigate pressure interference between neighboring CCS projects.
- Improved storage efficiency / increase capacity of a permitted CO₂ storage site.
- Reduce stress on sealing formation.
- Geosteer injected fluids (injection and extraction of brine).
- Divert pressure from potential leakage pathways.
- Improve injectivity, capacity, and storage efficiency.
- Reduce area of review (AOR).
- Accelerated pressure dissipation after injection.

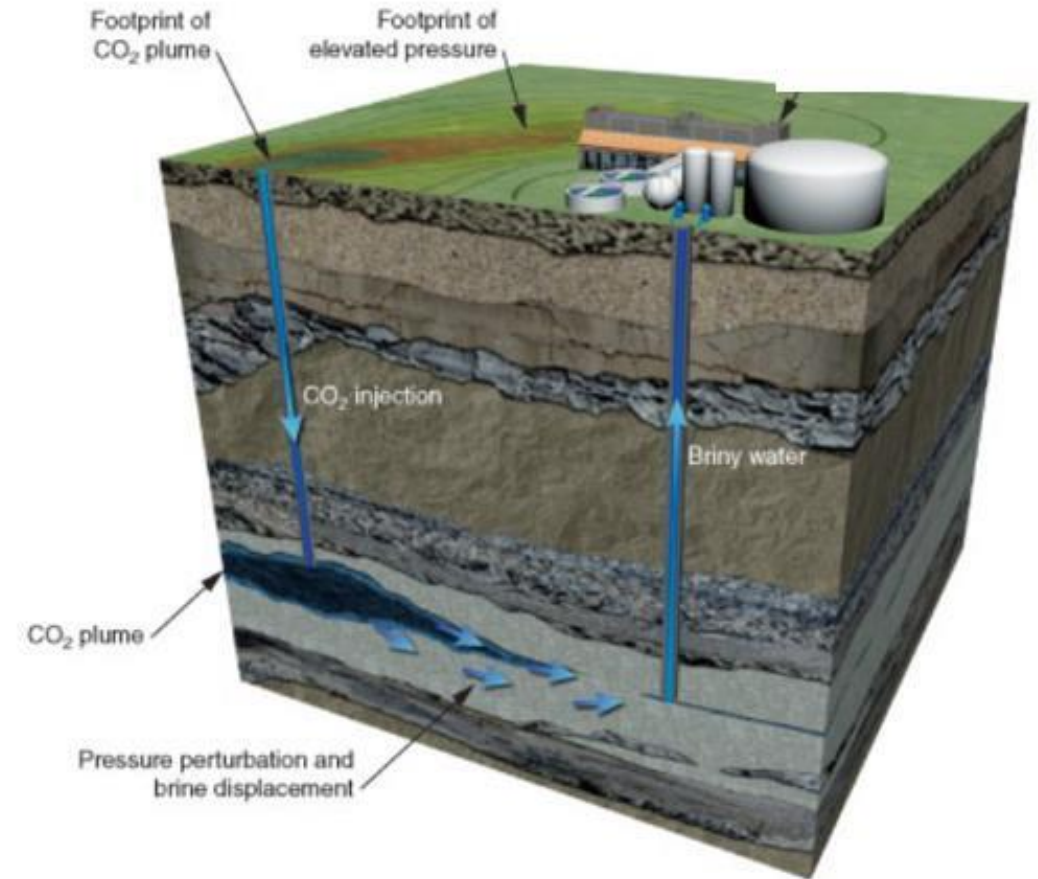


Illustration modified from Lawrence Livermore National Laboratory <https://str.llnl.gov/Dec10/aines.html>

Brine Treatment

- Alternate source of water.
- Reduced disposal volumes.
- Salable products for beneficial use.



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THANK YOU

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