



EERC



UNIVERSITY OF
NORTH DAKOTA

Critical Challenges. Practical Solutions.



Energy & Environmental Research Center (EERC)

Carbon Capture, Utilization, and Storage (CCUS) 101

USEA Educational Series on the basics of CCUS

Wednesday, October 8, 2025

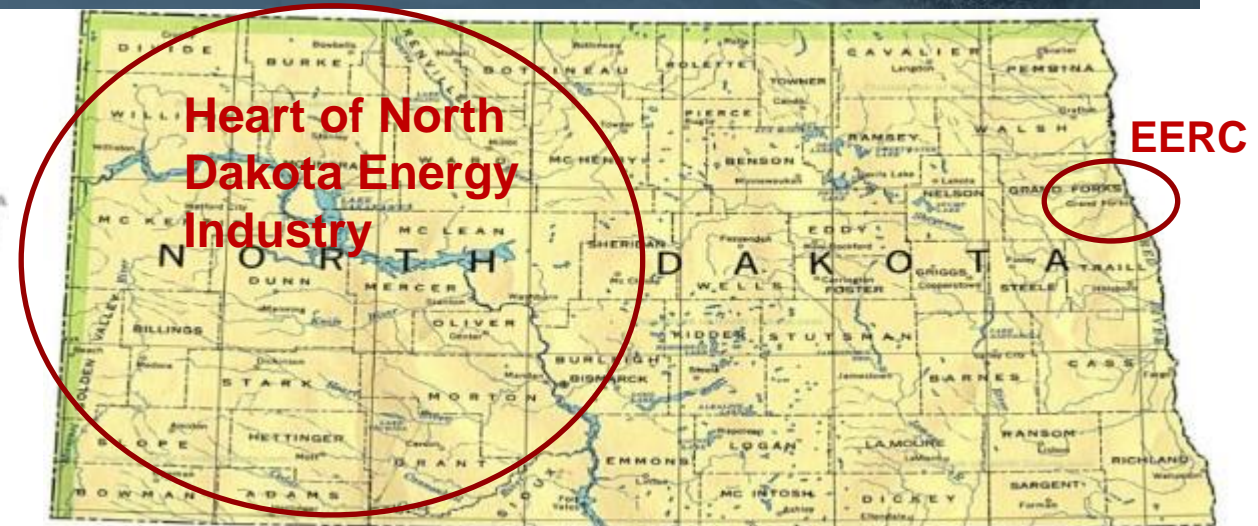
1:00 - 2:00 pm ET

Kevin C. Connors

Assistant Director for Regulatory Compliance and Energy Policy

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

- Nonprofit branch of the University of North Dakota.
- Focused on energy and environmental solutions.
- More than 254,000 square feet of state-of-the-art laboratory, demonstration, and office space.



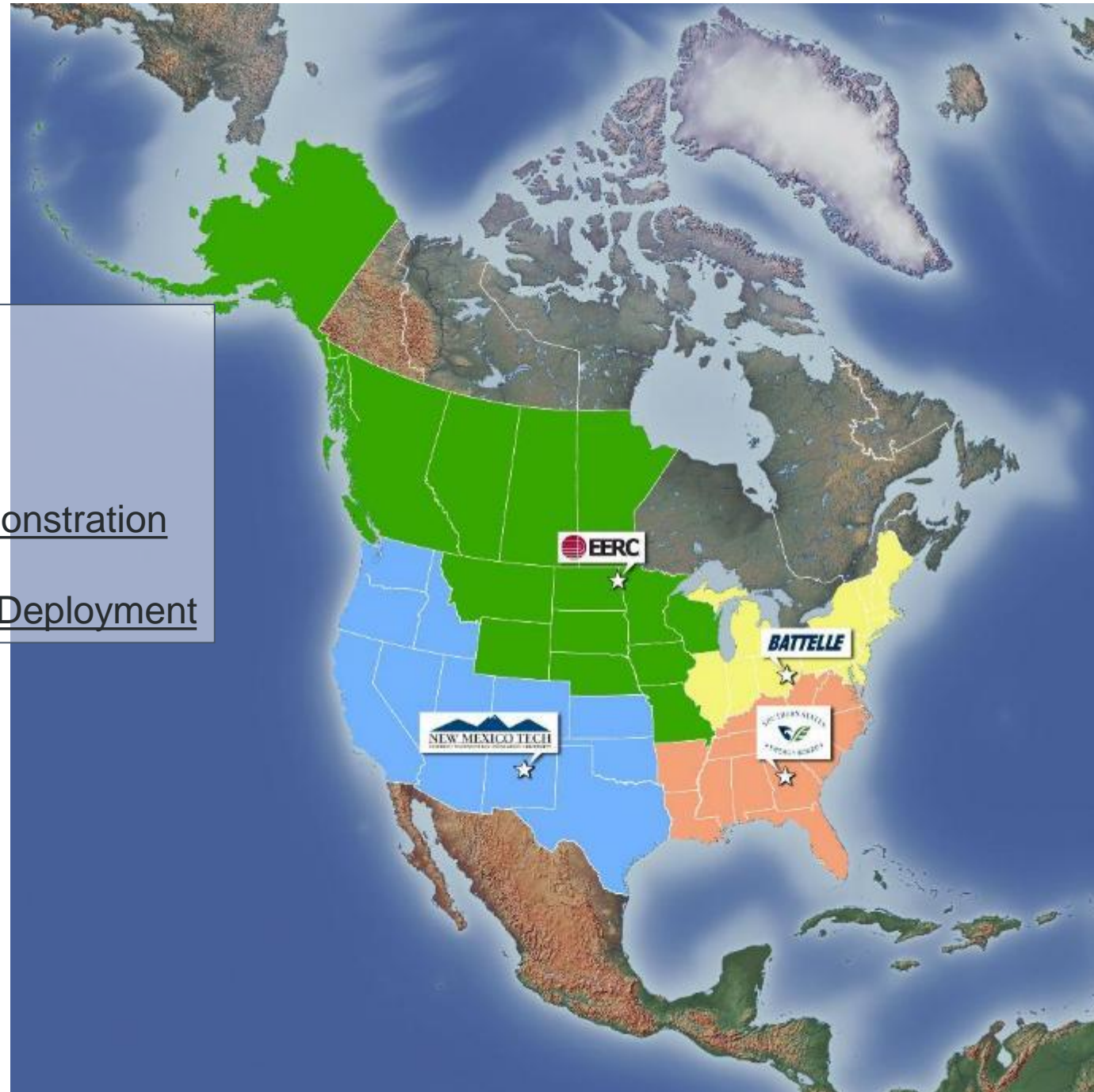
PCOR PARTNERSHIP

2003–2005 – PCOR Partnership: Characterization

2005–2008 – PCOR Partnership: Field Validation

2007–2019 – PCOR Partnership: Commercial Demonstration

2019–Present – PCOR Partnership: Commercial Deployment



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Institute of Northern Engineering
University of Alaska Fairbanks



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Energy Resources



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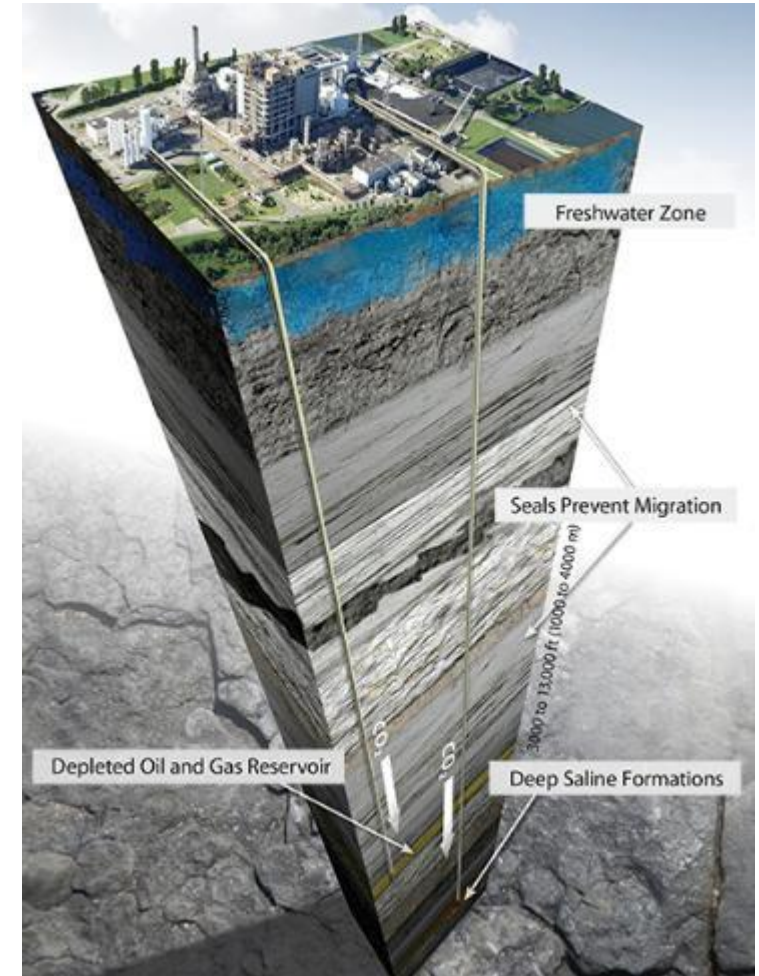


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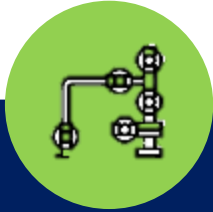


NATIONAL
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TECHNOLOGY
LABORATORY

CARBON DIOXIDE (CO₂) IS A COMMODITY



KEY TERMINOLOGY



Dedicated CO₂ Storage

Carbon storage in a non-oil-bearing geologic formation containing high saline or brine water, where the primary purpose is permanent storage.



Associated CO₂ Storage

CO₂ can be injected into depleted oil reservoirs to enhance oil recovery from the reservoir, ultimately resulting in permanently stored CO₂.



45Q Tax Credit

A U.S. IRS tax credit for carbon oxide sequestration—or capture and storage.



Pore Space

Tiny space between rock grains of a geologic formation, occupied by a fluid. Porosity and permeability are terms used to describe the quality of the reservoir rock



Caprock

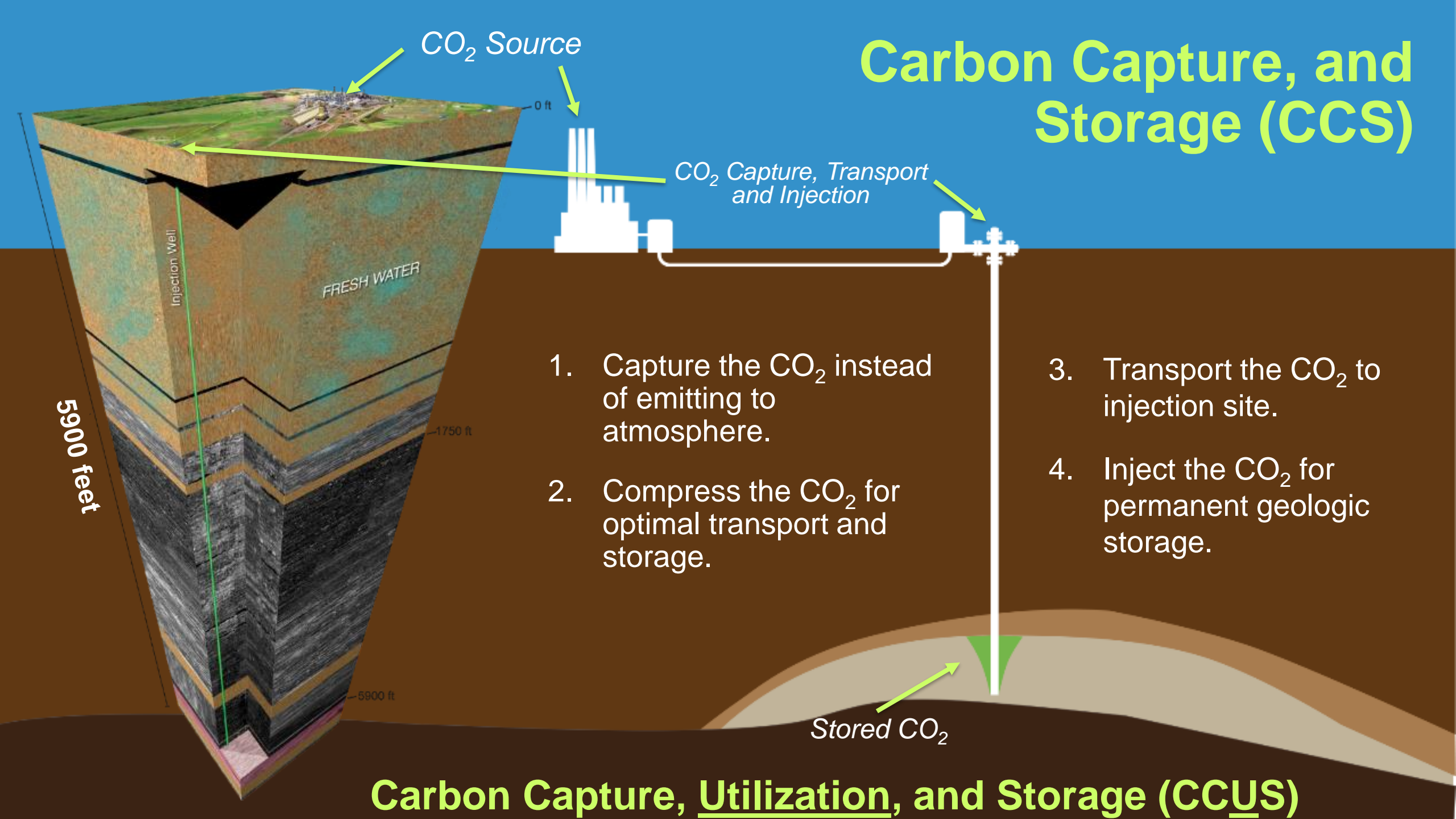
Layer or layers of rock that are impermeable, acting as an upper seal to contain liquids and gases injected into the storage reservoir (a.k.a. confining zone).



Storage Reservoir

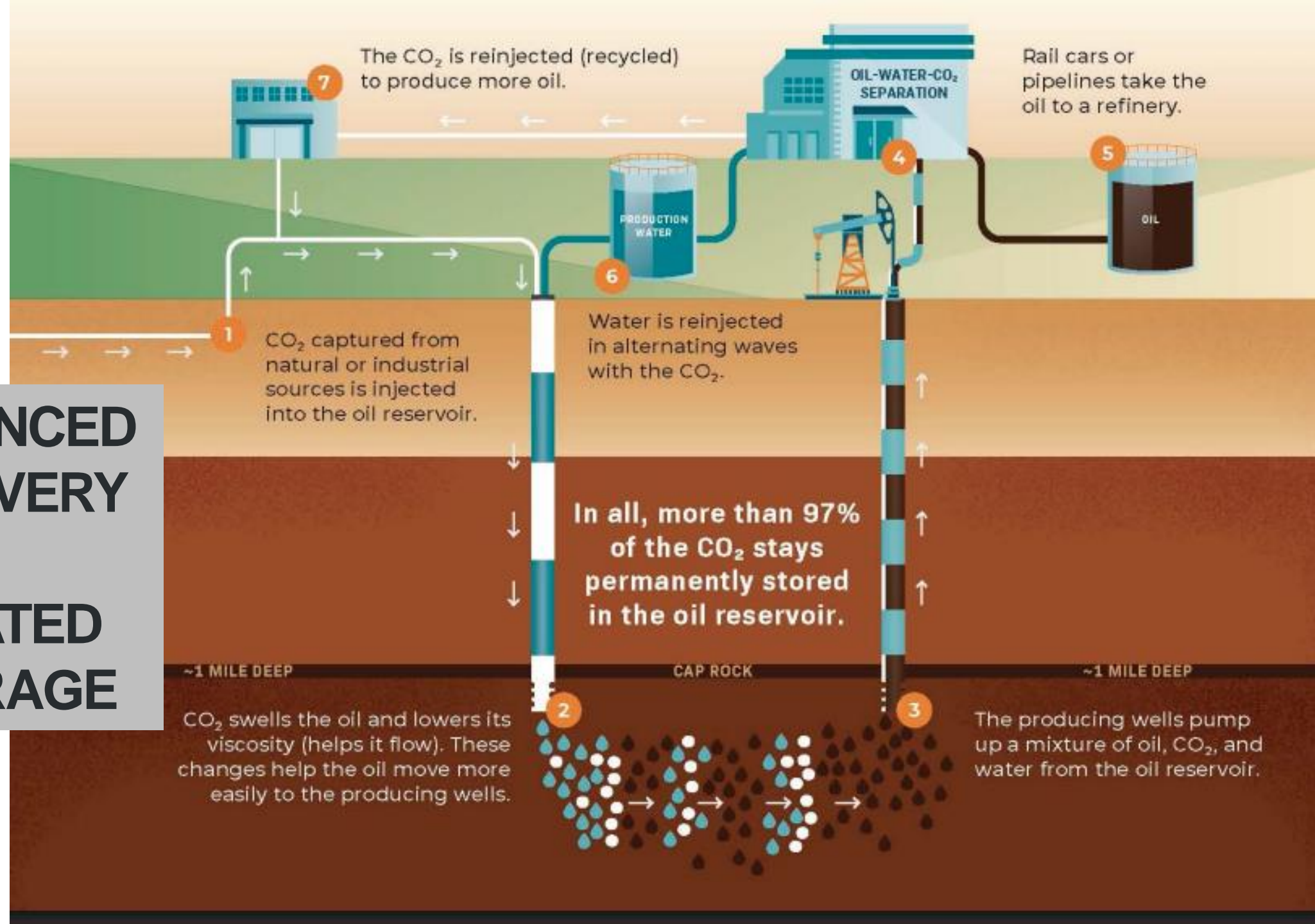
An underground geologic formation that is not a source of drinking water, and has the properties to inject into and store carbon dioxide (a.k.a injection zone)

Carbon Capture, and Storage (CCS)



Carbon Capture, Utilization, and Storage (CCUS)

CO₂ ENHANCED OIL RECOVERY AND ASSOCIATED CO₂ STORAGE

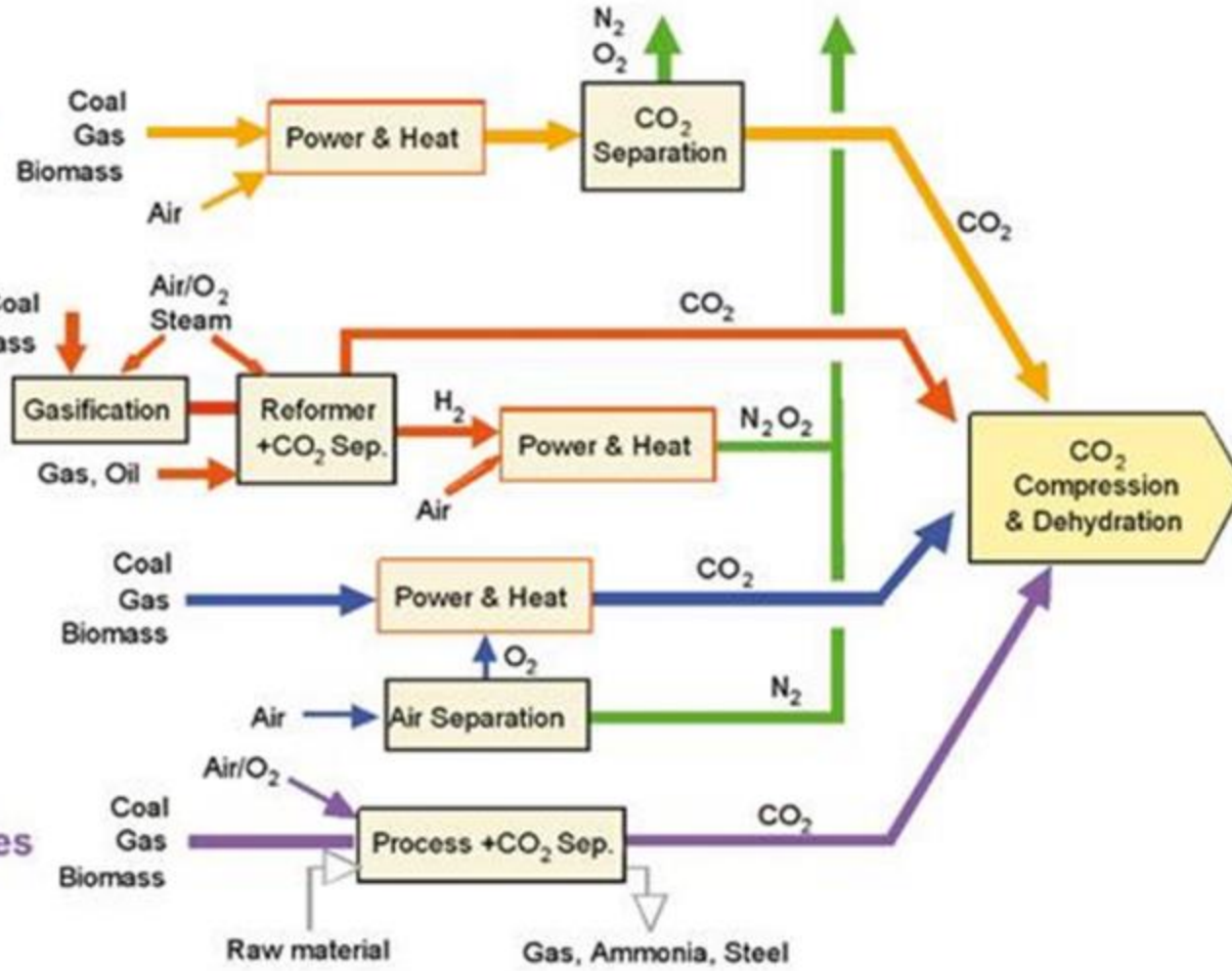


APPROACHES TO THE CAPTURE OF CO₂

Coal-Fired Electricity Generation

Post combustion

Coal: 10%-18% CO₂
Nat. Gas: 4%-8% CO₂



Synfuels

Pre combustion

20%-30% CO₂


Oxyfuel

Can be >80% CO₂


Ethanol Production

Industrial processes

From Metz, B. et al., 2005, *Intergovernmental Panel on Climate Change Special Report on Carbon Dioxide Capture and Storage*.

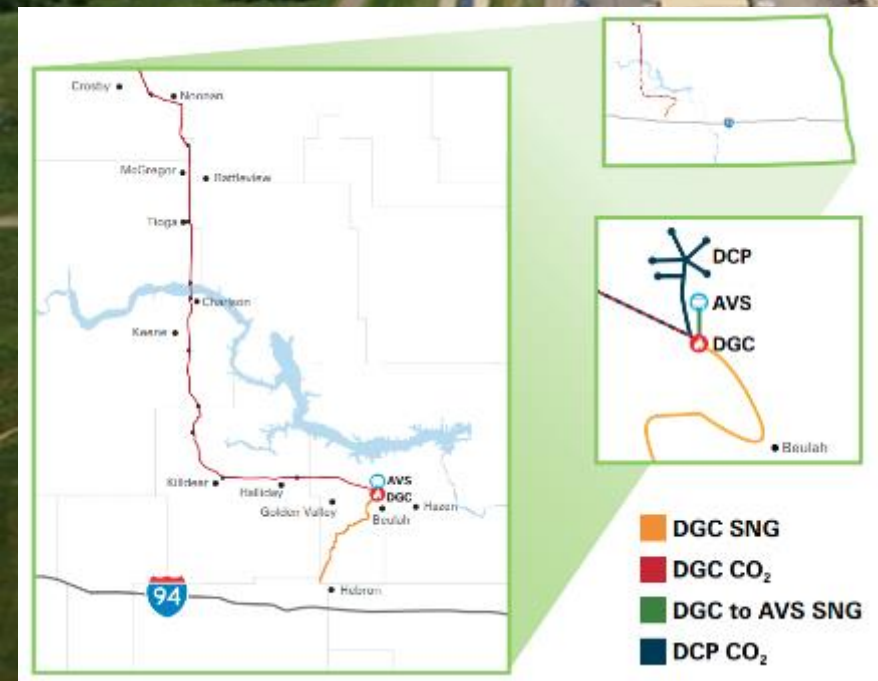
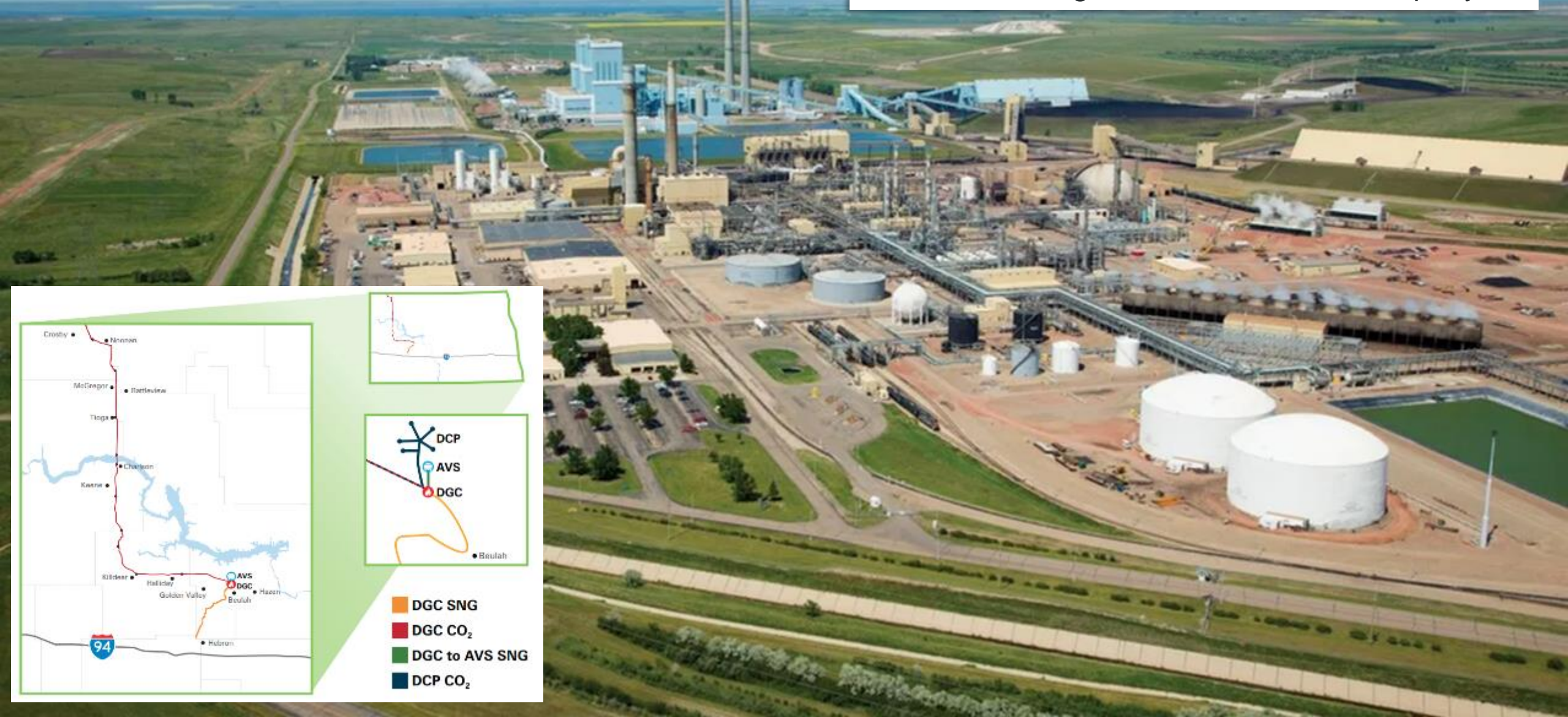
An aerial photograph of the Boundary Dam Unit #3 power plant in Estevan, Saskatchewan. The plant features several large, light-colored industrial buildings with flat roofs. Four prominent smokestacks with red and white horizontal stripes rise from the facility. A large, dark, circular pond is visible to the right of the main building complex. The surrounding landscape is flat and open, with some parking lots filled with vehicles and various smaller structures scattered around the main plant area.

Boundary Dam Unit #3, 2014
Estevan, Saskatchewan
Shell Cansolv Technology
110 MW
Approx. 1 million metric tons
per year

An aerial photograph of the Petra Nova Project industrial facility. The central feature is a tall, multi-story distillation column with a complex steel framework. To its right is a large, cylindrical storage tank. In the foreground, there are several smaller storage tanks and a network of pipes. The facility is surrounded by a parking lot with several vehicles, a road, and a grassy area. In the background, there are more industrial buildings and a large body of water.

Petra Nova Project, Dec. 2016
W.A. Parish Generating Station
Thompsons, Texas
MHI Technology
240 MW_e (slipstream system)
Approx. 2 million metric tons per year

Dakota Gasification, Active CCS and CCUS
Beulah, North Dakota
EOR: 42 million metric tons to Canada
Dedicated Storage: 2.7 million metric tons per year

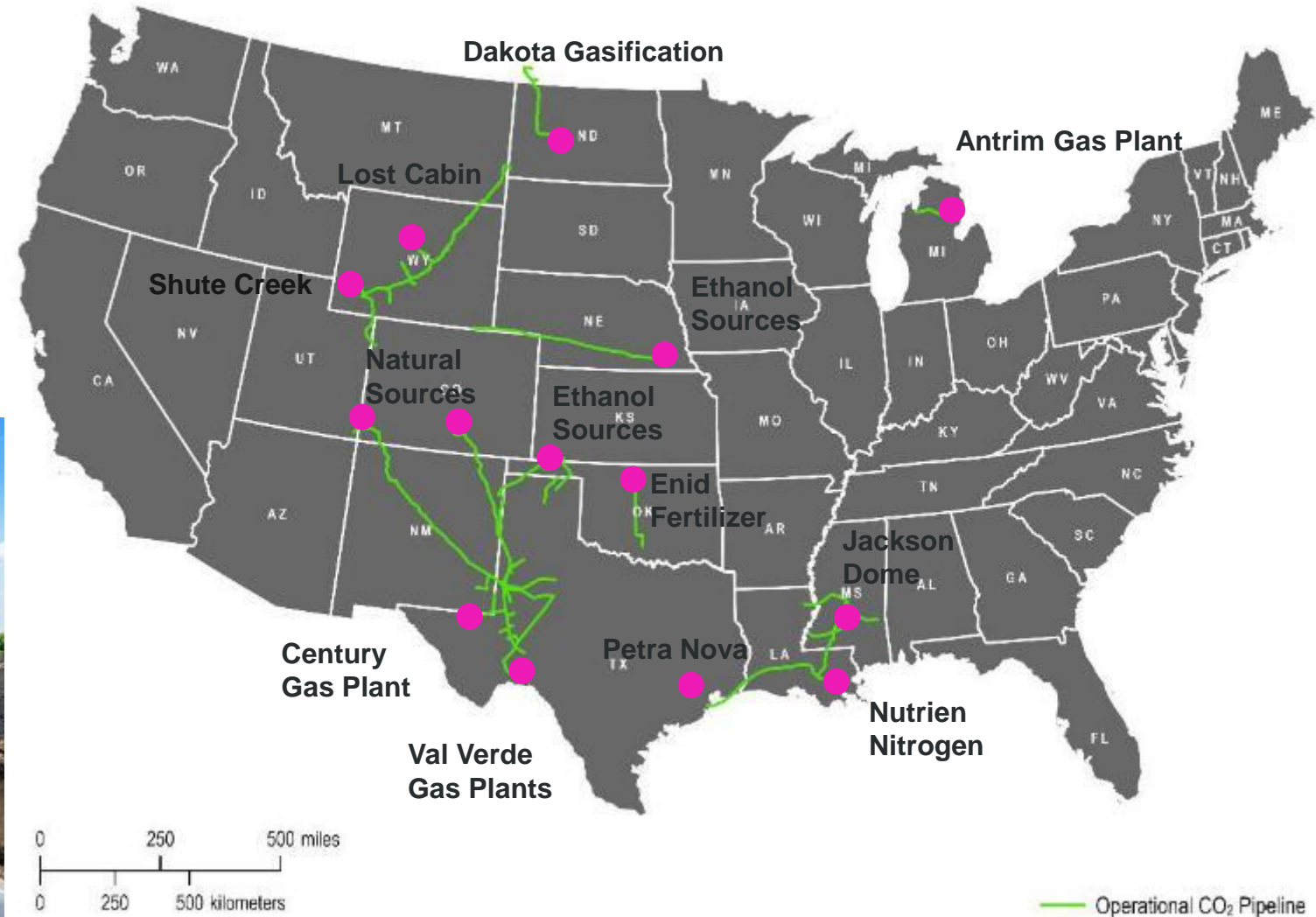


Richardton CCS, Active CCS
Richardton, North Dakota
Approx. 180,000 metric tons per year



CO₂ PIPELINES IN THE U.S.

- CO₂ has been safely transported via pipeline since the 1970's.
- The U.S. has over 5,000 miles of CO₂ pipeline.



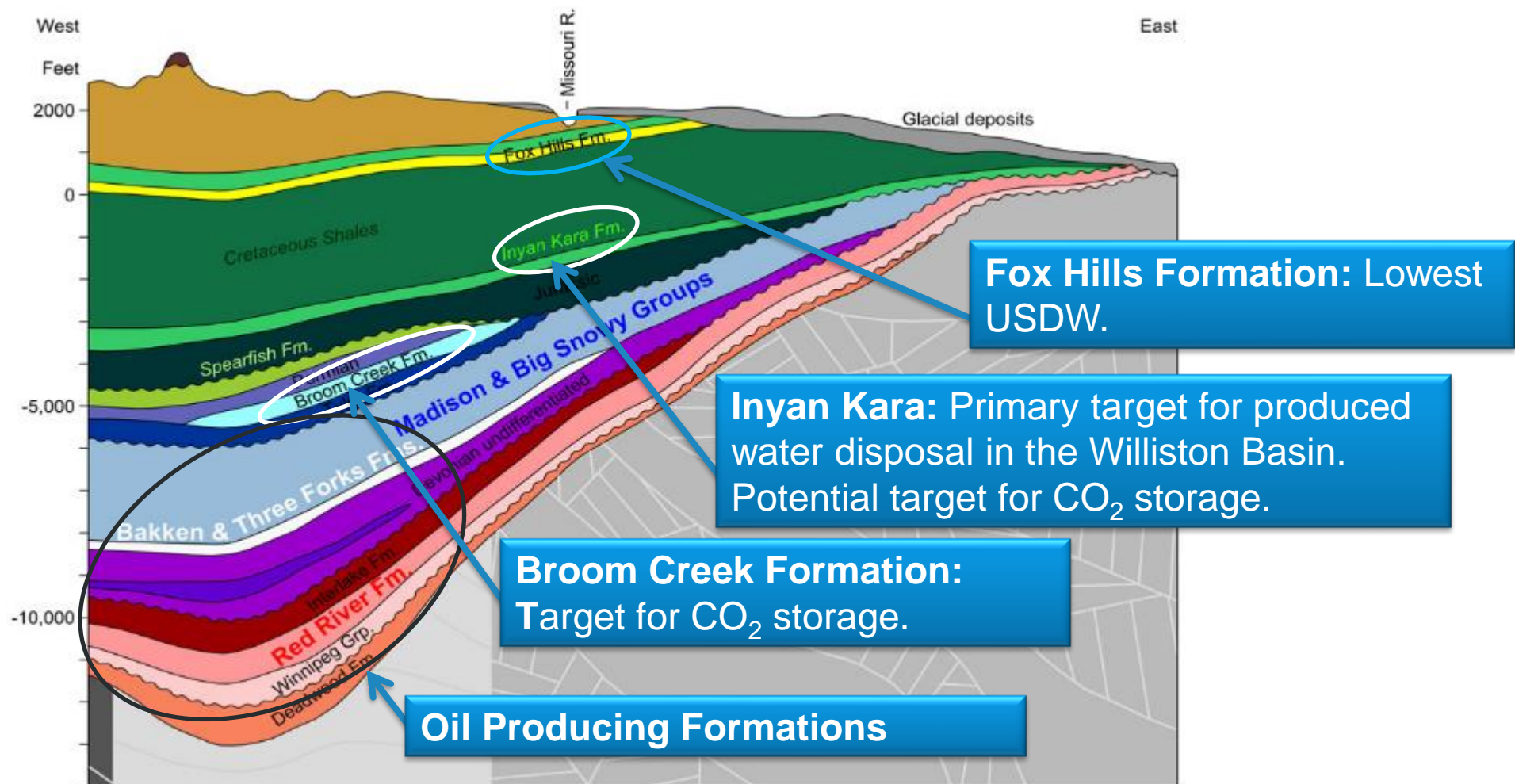


SEDIMENTARY BASINS IN THE PCOR PARTNERSHIP REGION

WILLISTON BASIN



WILLISTON BASIN CROSSSECTION

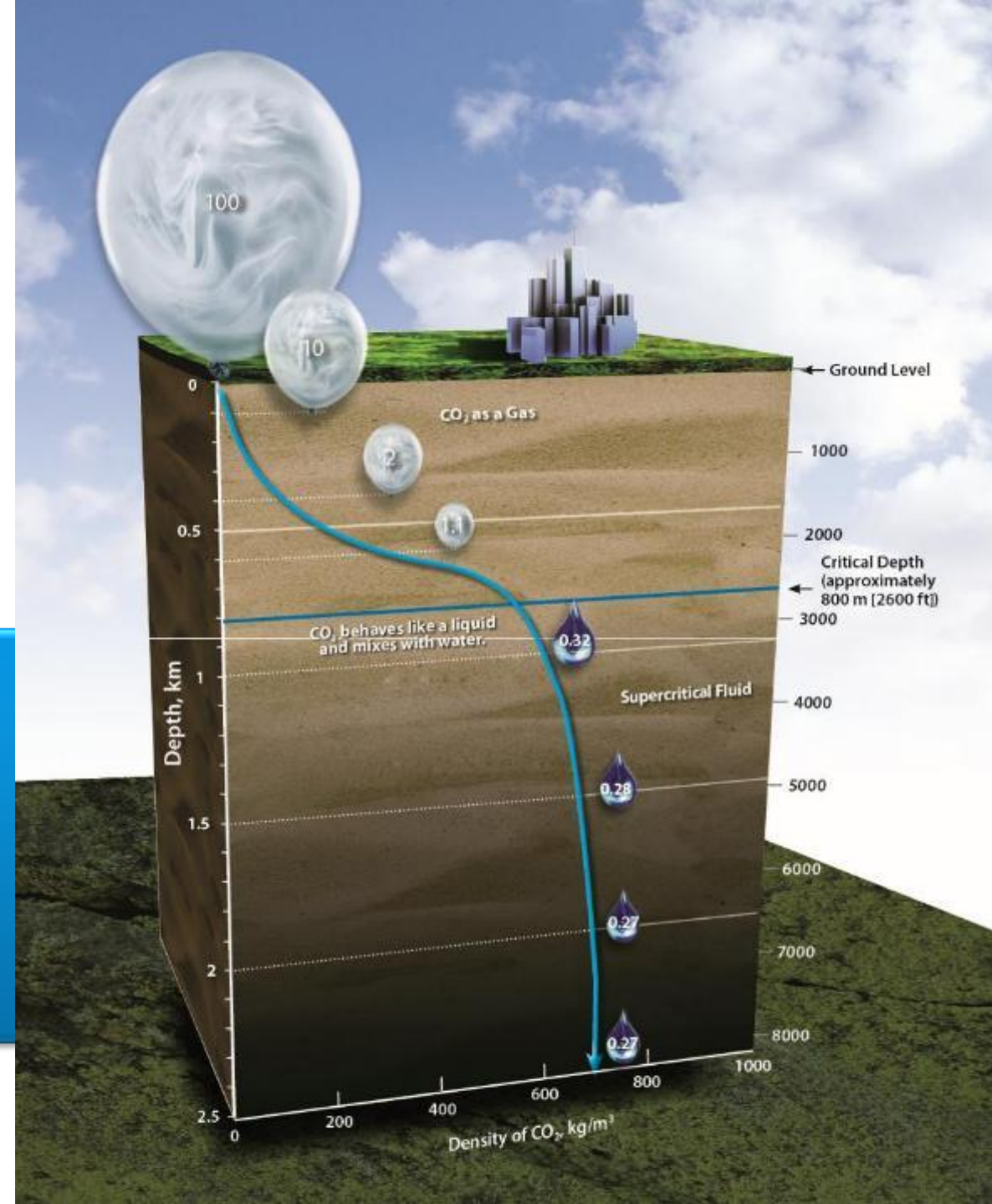


CRITICAL SUBSURFACE CHARACTERISTICS

- Depth
- Porosity/permeability
- Good cap rock
- Appropriate salinity
- No natural leakage pathways

Depth

- Below approximately 2600 ft, CO₂ becomes a supercritical fluid.
- CO₂ will behave like a liquid.
- High density of the CO₂ allows for more storage in a given volume.

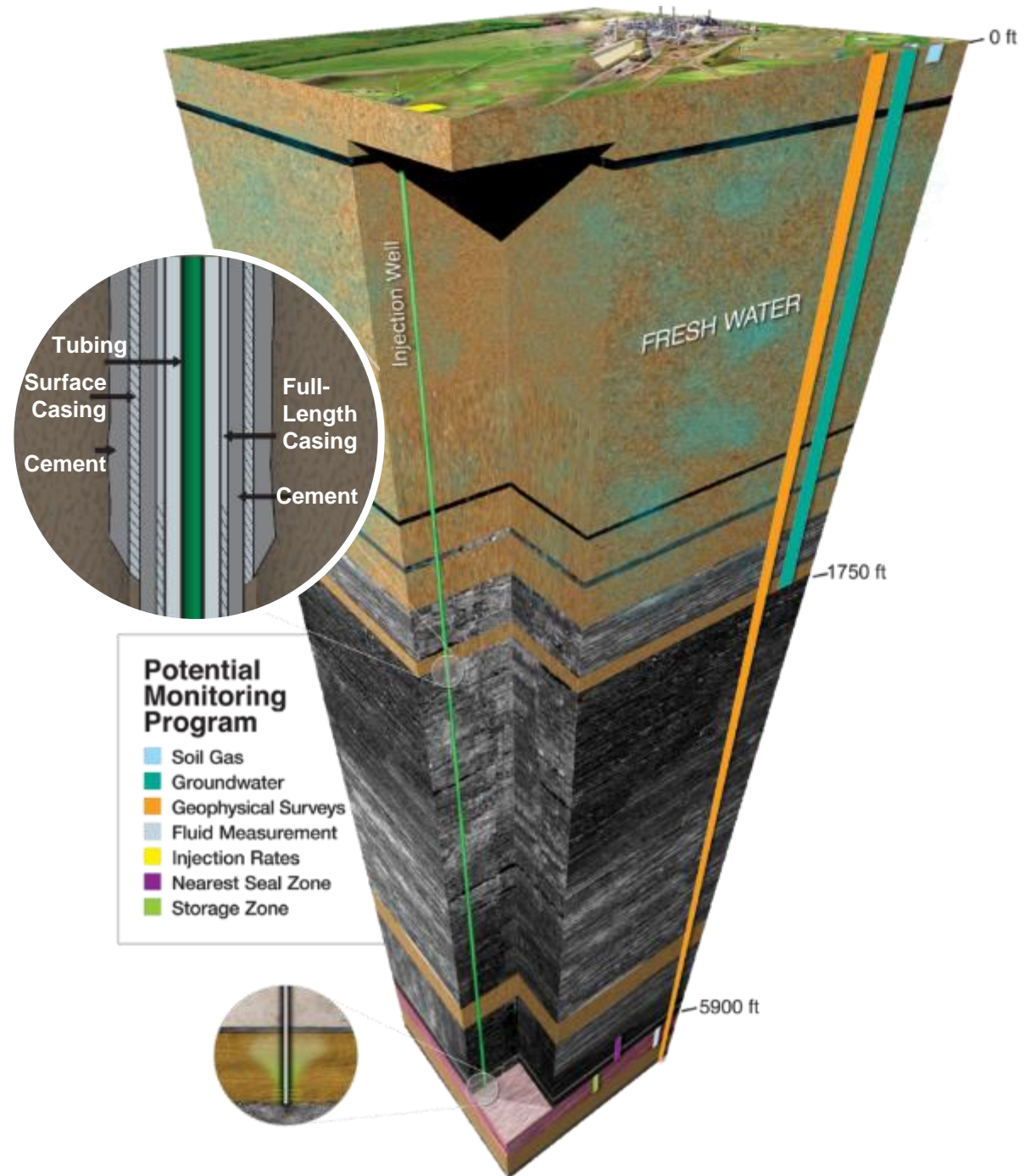


POROSITY AND PERMEABILITY





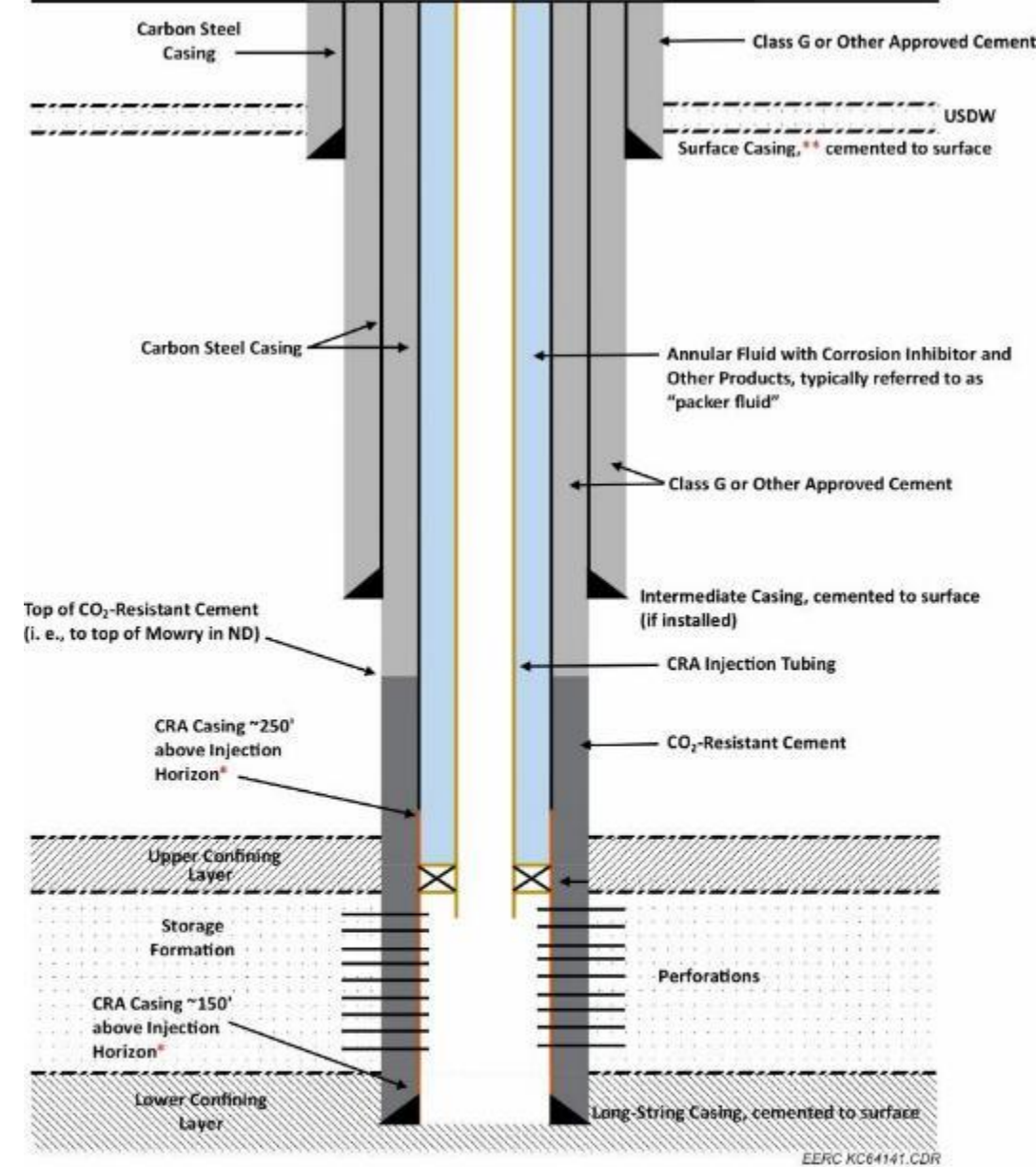
ENSURING HUMAN SAFETY AND PROTECTING GROUNDWATER



DRINKING WATER PROTECTION

Multiple layers of steel casing and cement isolate and protect the freshwater aquifer systems.

Well Integrity ensures injected CO₂ is safely and permanently stored



NOTES:

1. Drawing is not to scale but to provide a representation for the construction of a CCS injection well.
2. CRA = corrosion-resistant alloy
3. Injection packer is to be installed within 50' of the top perforation.

*Indicated lengths are provided as a reference and would be defined on a project-by-project basis.

**Surface casing is required to be set 50' below lowermost source of drinking water.

CO₂ IS MONITORED EVERY STEP OF THE WAY





REGIONAL CCUS ACTIVITY

~40 years of CCUS Operations
>1600 miles of CO₂ Pipeline
>176 million tonnes of CO₂ Stored*

*Tonnes stored as of Sept. 2025

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A wide-angle photograph of a university campus at sunset. The sun is low on the left, casting a warm glow over the scene. In the foreground, there are trees with yellowing leaves. In the background, several large, multi-story brick buildings are visible, along with a parking lot filled with cars.

THANK YOU

Critical Challenges. Practical Solutions.