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

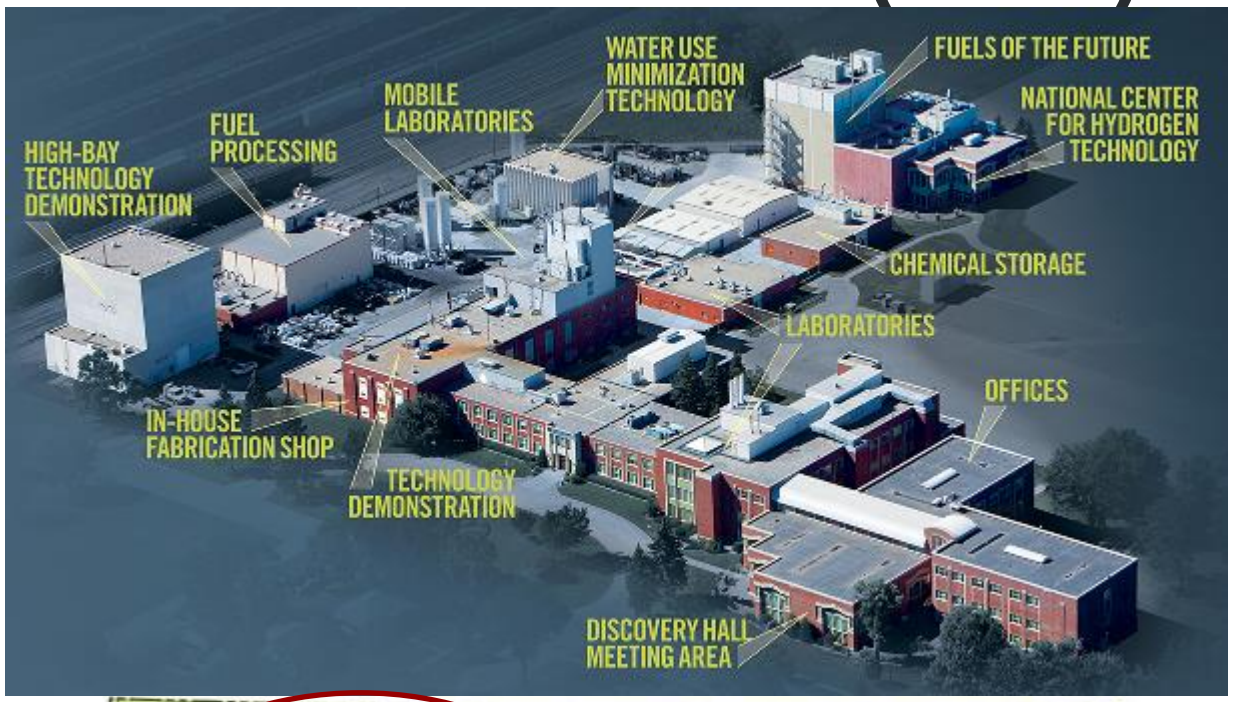
1:00 - 2:00 pm ET

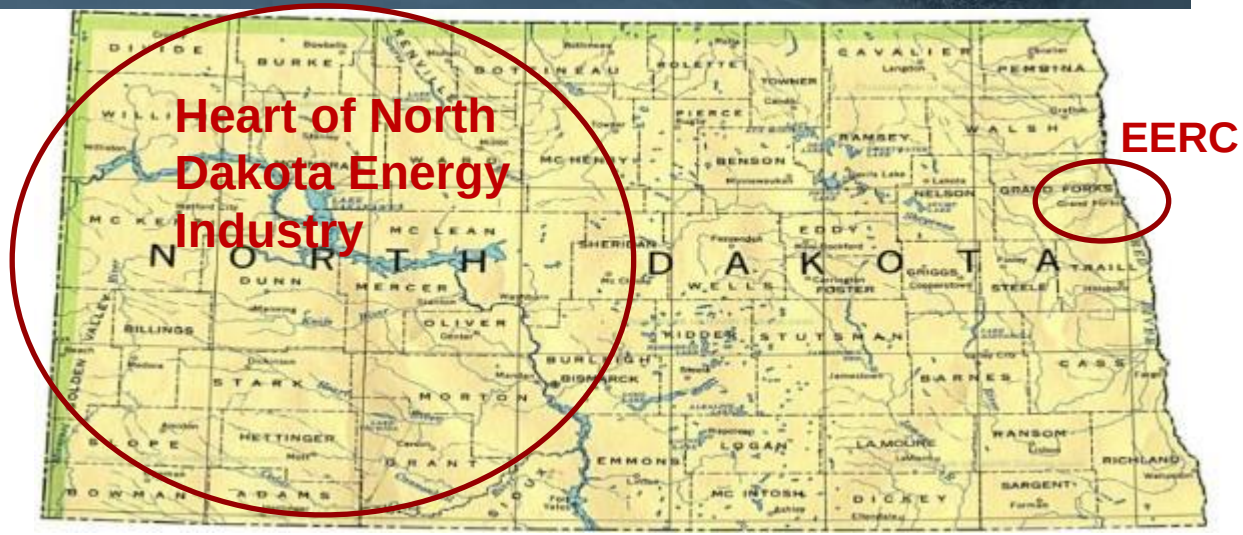
Kevin C. Connors

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.





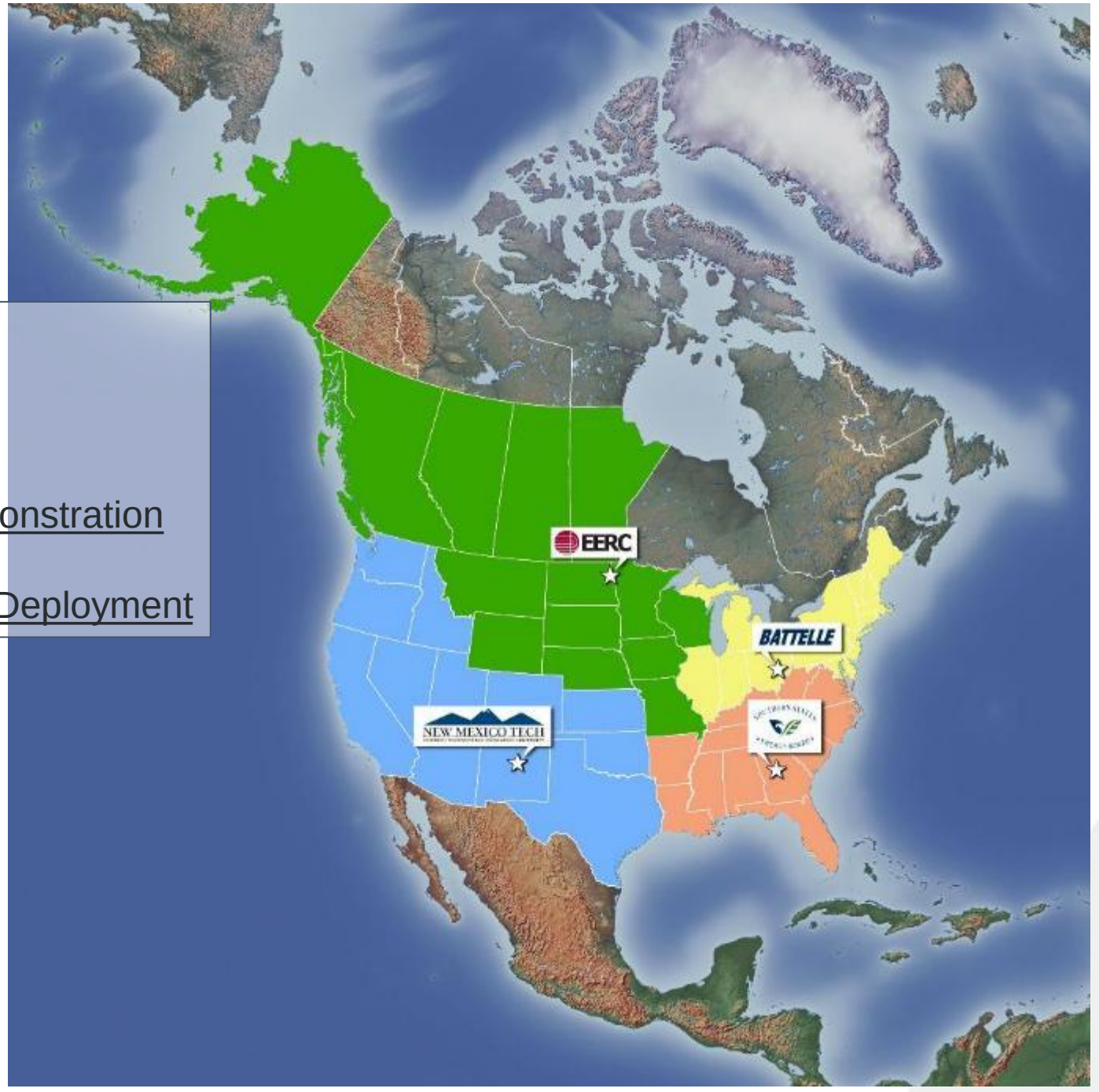
PCOR PARTNERSHIP

2003–2005 – PCOR Partnership: Characterization

2005–2008 – PCOR Partnership: Field Validation

2007–2019 – PCOR Partnership: Commercial Demonstration

2019–Present – **PCOR Partnership:** Commercial Deployment



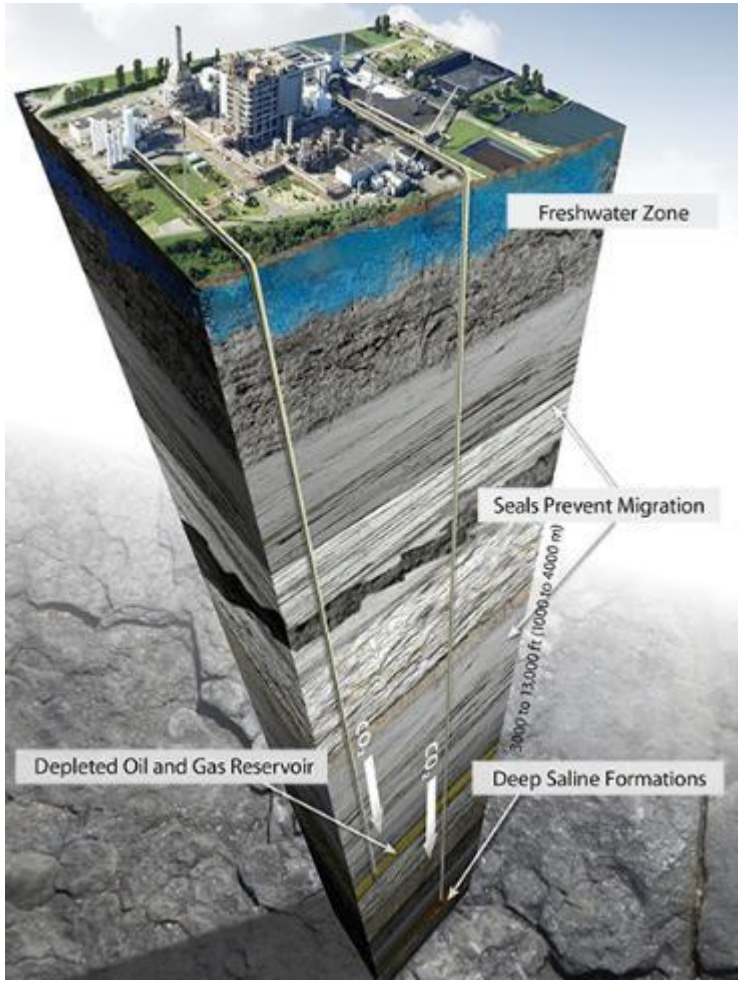
U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

Institute of Northern Engineering
University of Alaska Fairbanks

University of Wyoming School of Energy Resources

PCOR Partnership | EERC | U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

CARBON DIOXIDE (CO_2) IS A COMMODITY



KEY TERMINOLOGY

Dedicated CO_2 Storage

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

Associated CO_2 Storage

CO_2 can be injected into depleted oil reservoirs to enhance oil recovery from the reservoir, ultimately resulting in permanently stored CO_2.

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

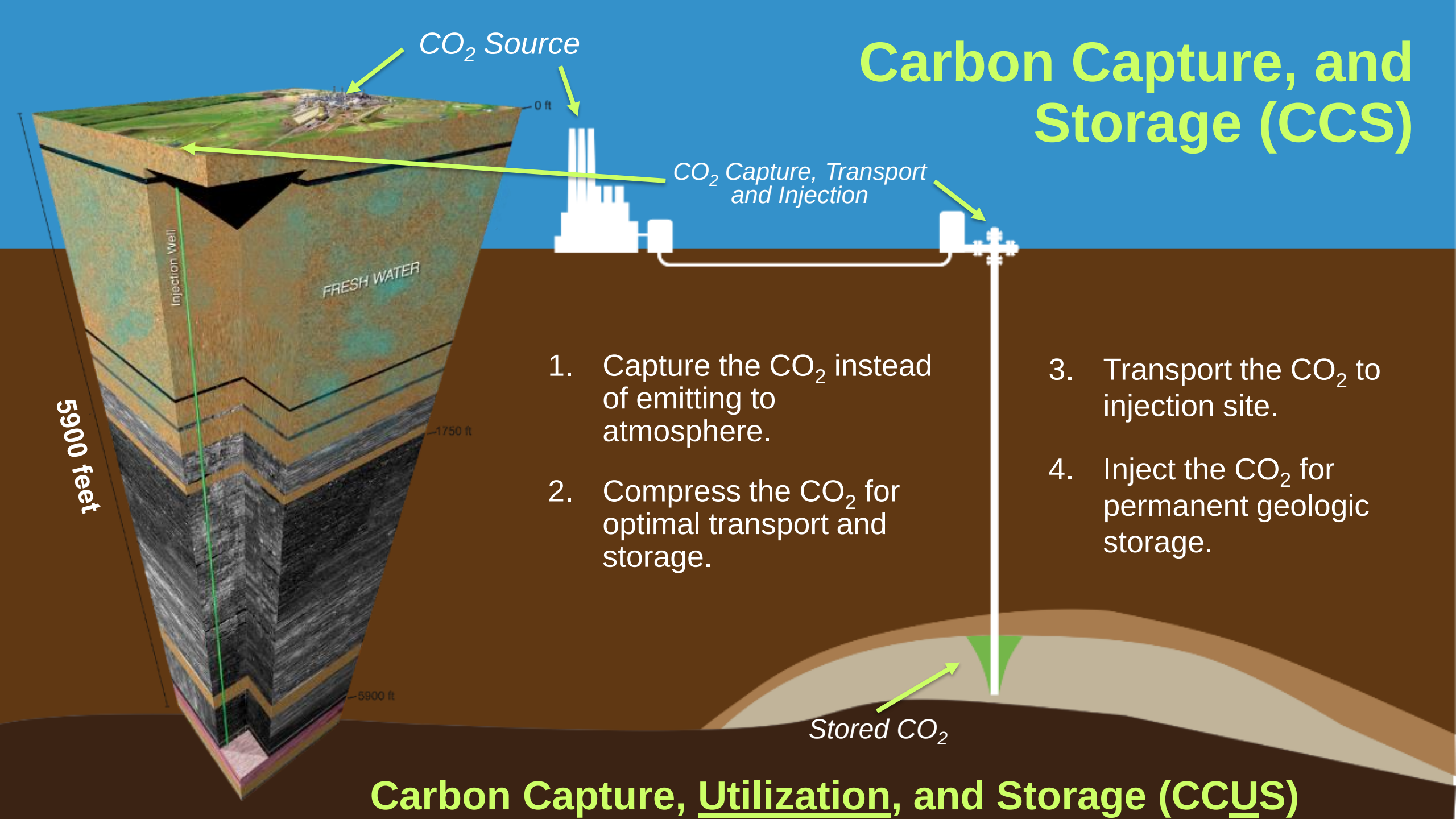
Caprock

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)

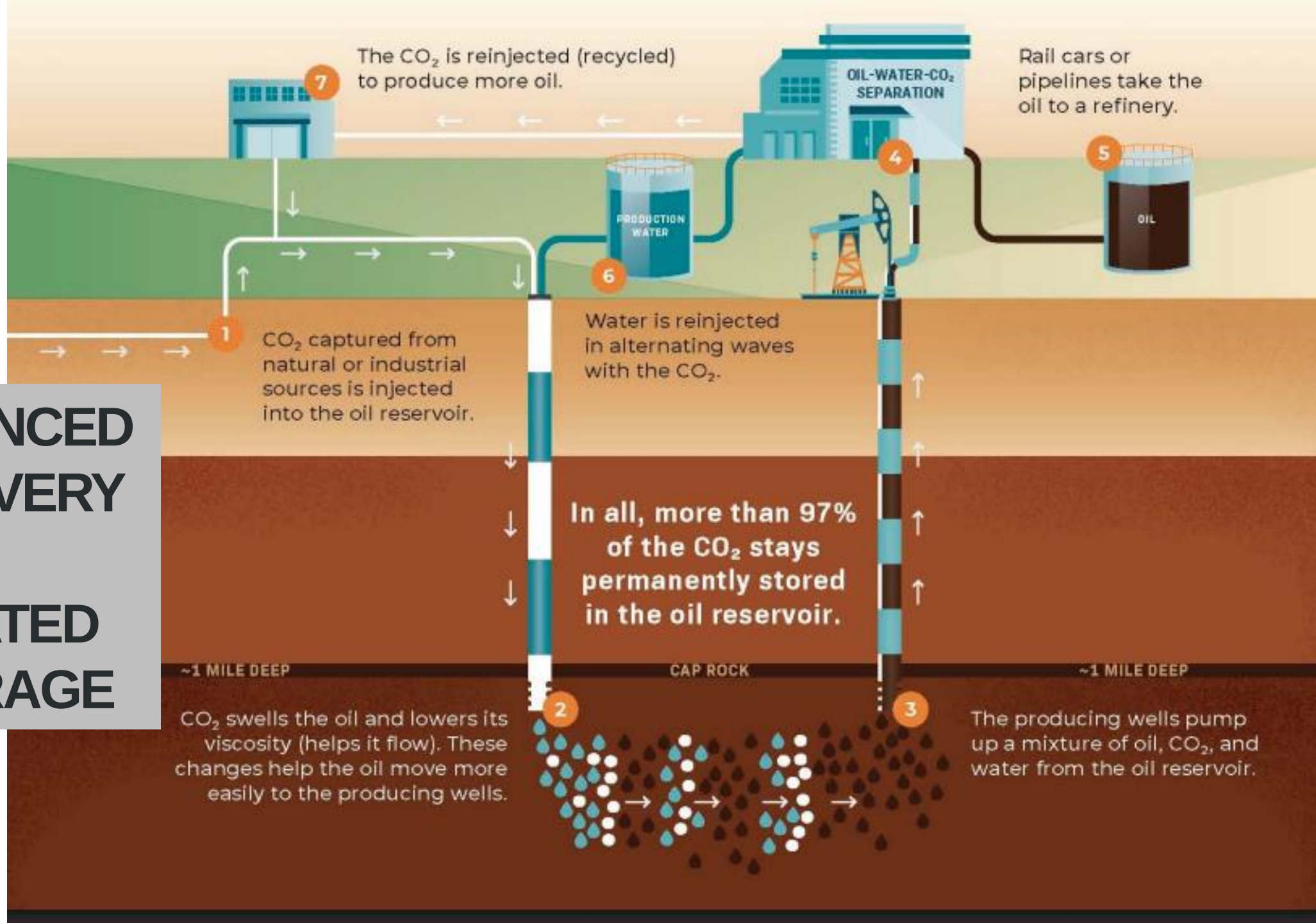
Carbon Capture, and Storage (CCS)



1. Capture the CO_2 instead of emitting to atmosphere.
2. Compress the CO_2 for optimal transport and storage.
3. Transport the CO_2 to injection site.
4. Inject the CO_2 for permanent geologic storage.

Carbon Capture, Utilization, and Storage (CCUS)

CO_2 ENHANCED OIL RECOVERY AND ASSOCIATED CO_2 STORAGE

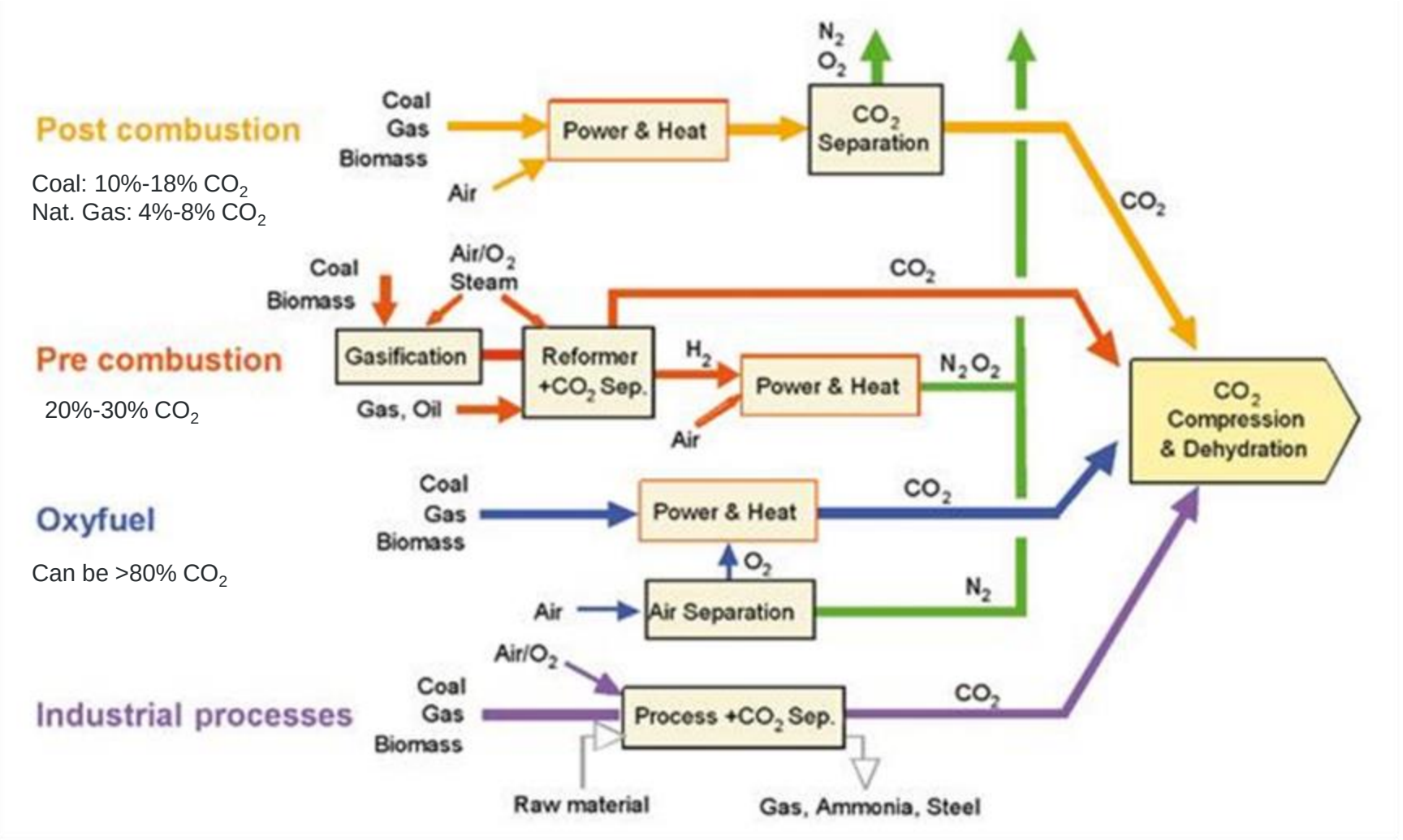


APPROACHES TO THE CAPTURE OF CO_2

Coal-Fired Electricity Generation

Synfuels

Ethanol Production



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

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

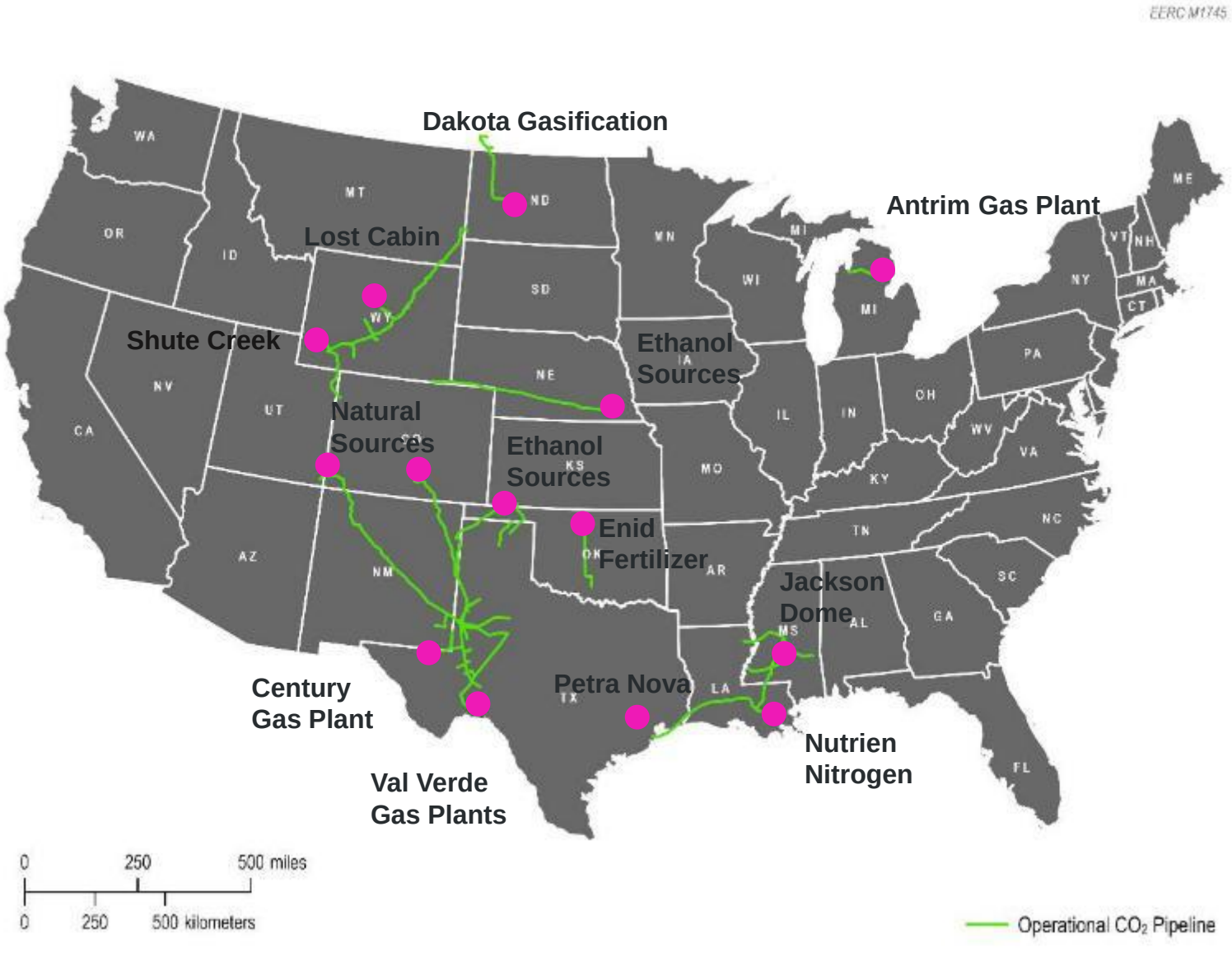

Petra Nova Project, Dec. 2016
W.A. Parish Generating Station
Thompsons, Texas
MHI Technology
240 MWe (slipstream system)
Approx. 2 million metric tons per year

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

CO_2 PIPELINES IN THE U.S.

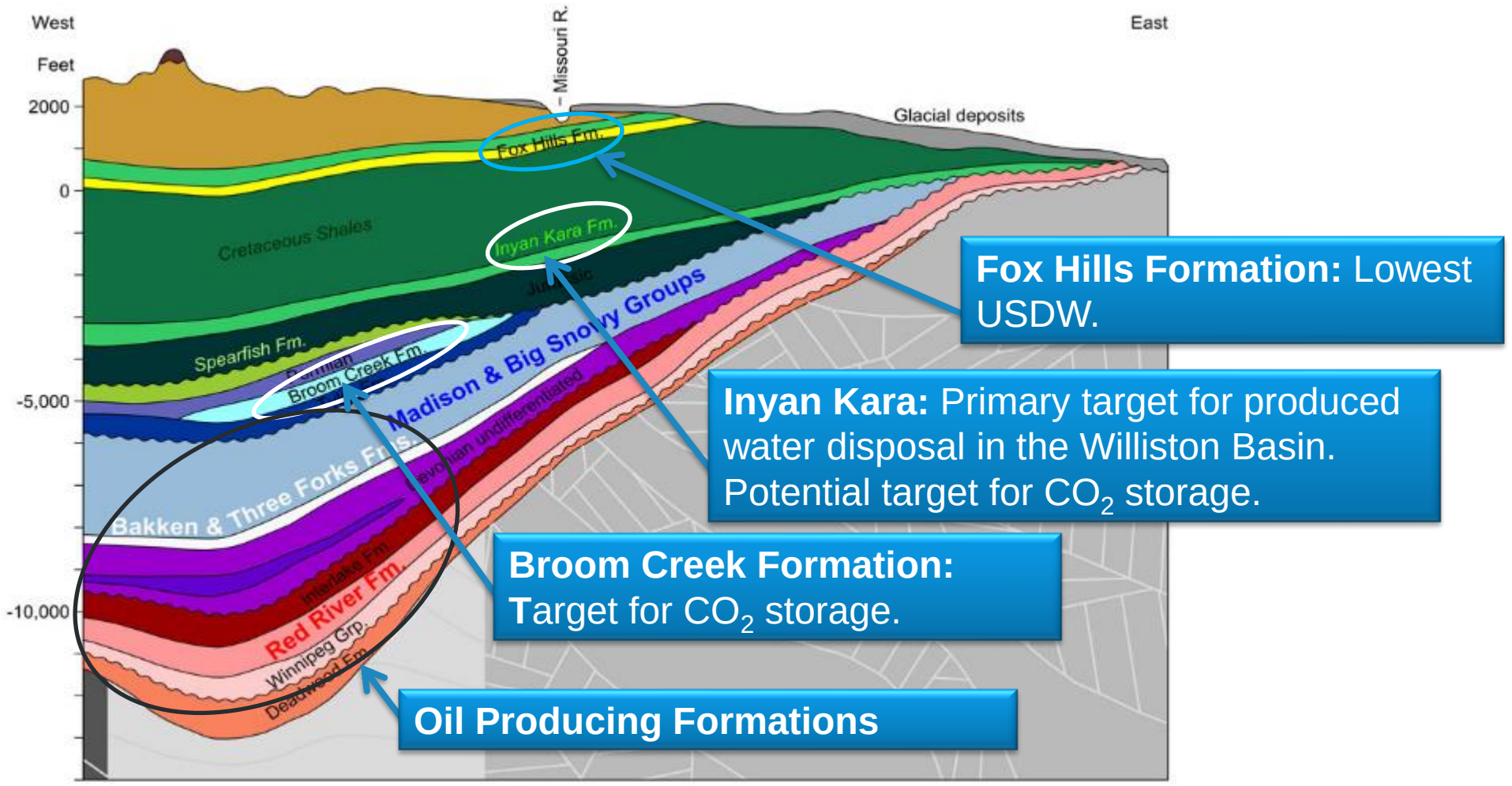
- CO_2 has been safely transported via pipeline since the 1970's.
- The U.S. has over 5,000 miles of CO_2 pipeline.



SEDIMENTARY BASINS IN THE PCOR PARTNERSHIP REGION

WILLISTON BASIN

WILLISTON BASIN CROSSSECTION

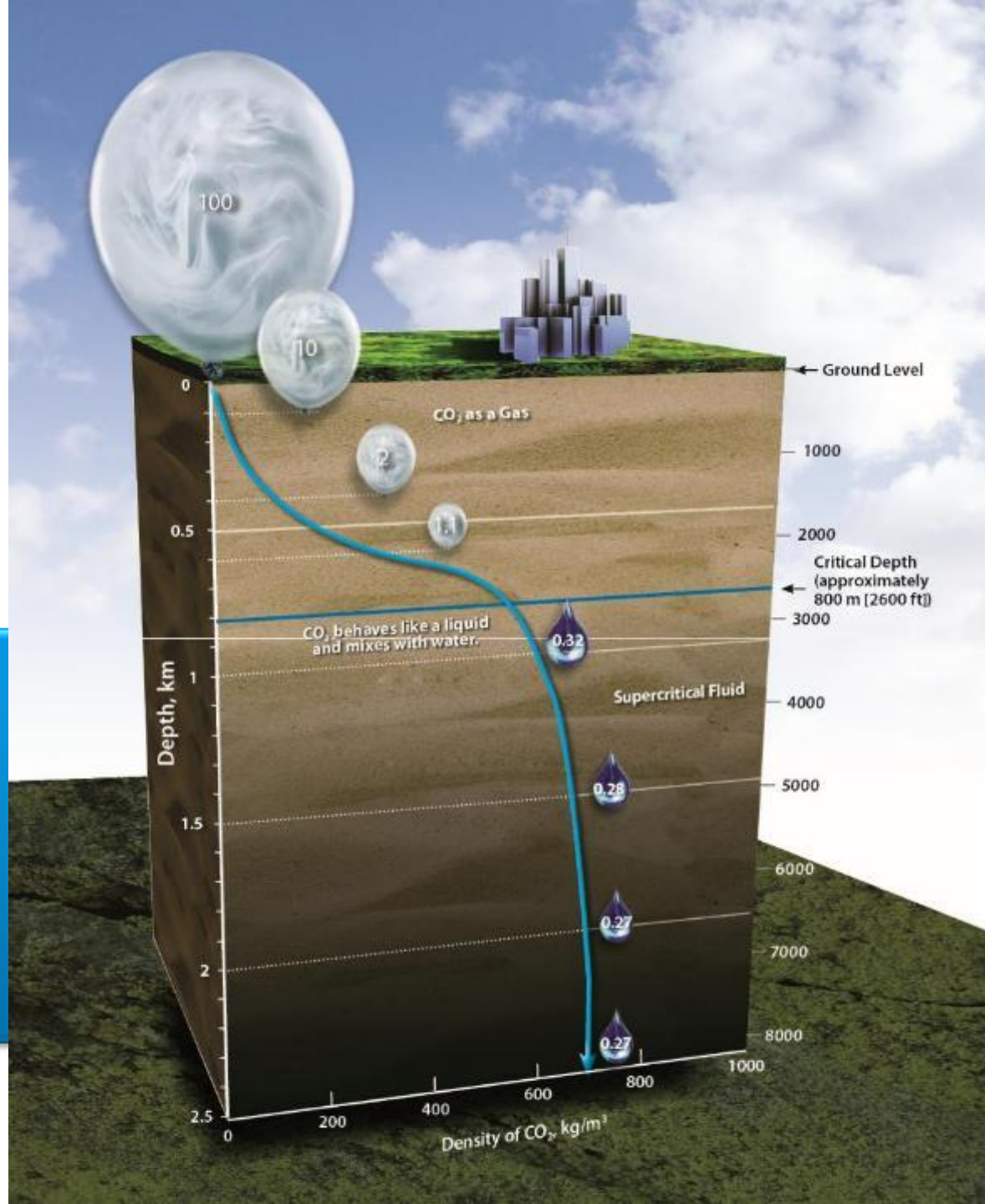


CRITICAL SUBSURFACE CHARACTERISTICS

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

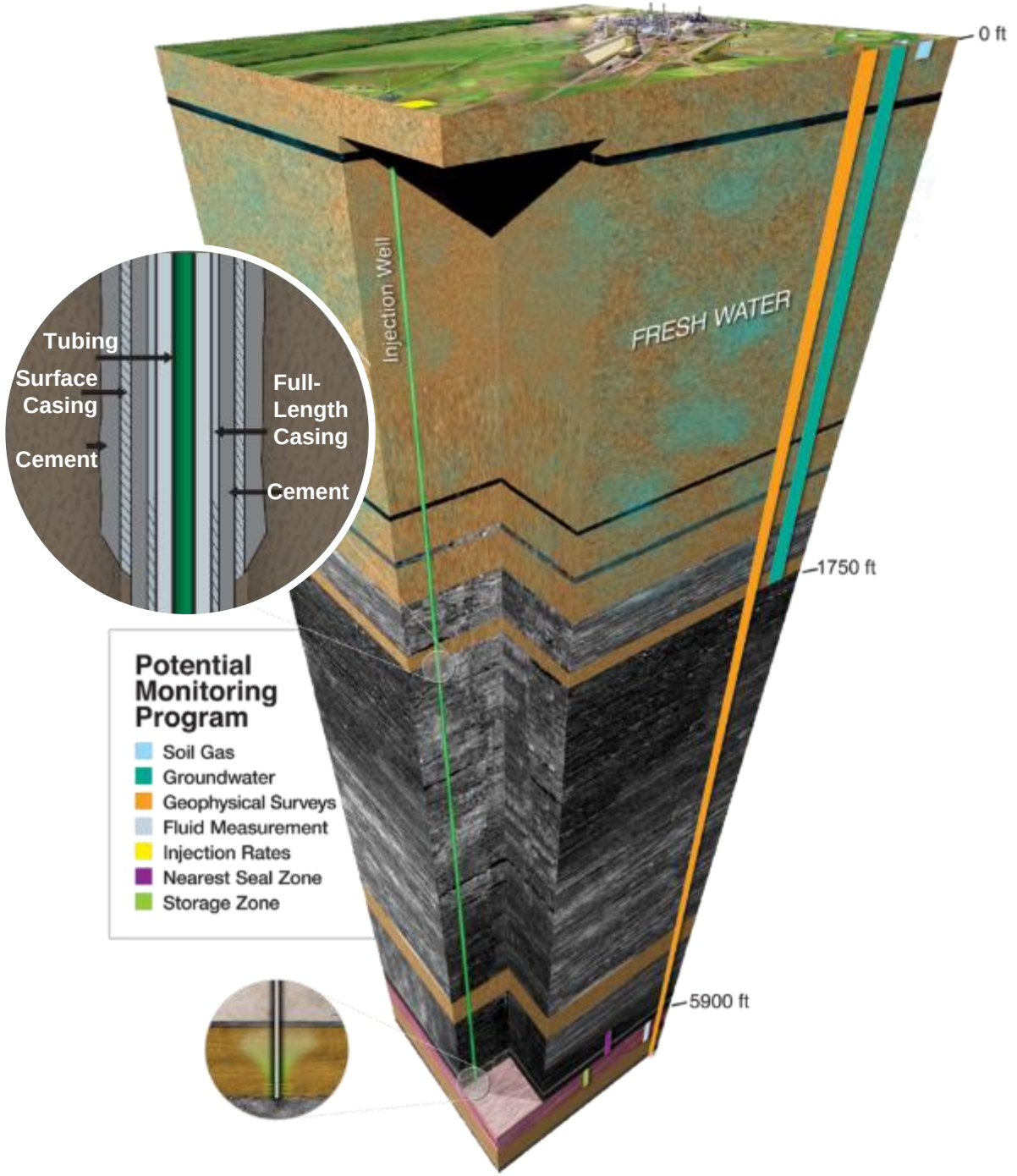
Depth

- Below approximately 2600 ft, CO_2 becomes a supercritical fluid.
- CO_2 will behave like a liquid.
- High density of the CO_2 allows for more storage in a given volume.



POROSITY AND PERMEABILITY

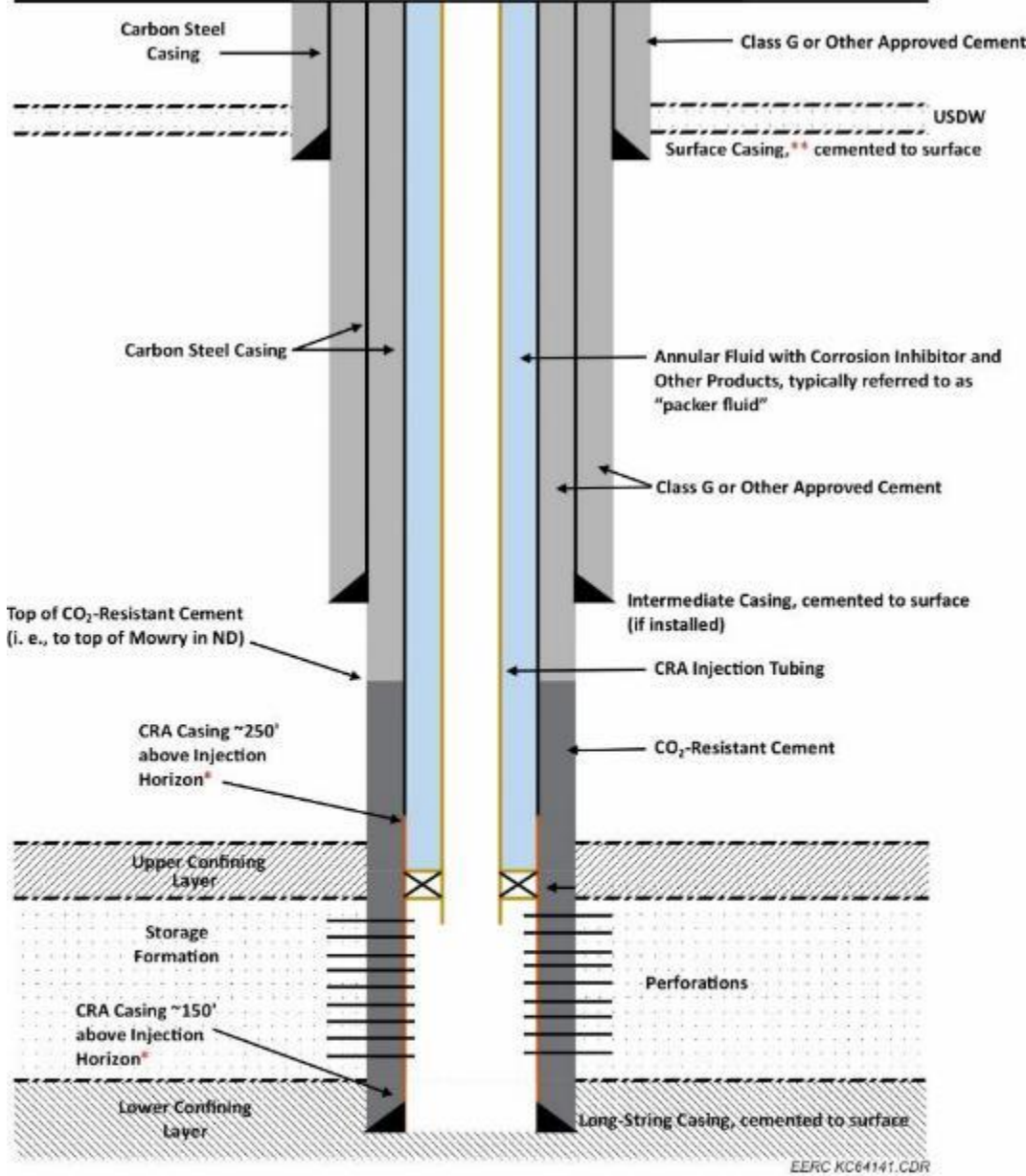
ENSURING HUMAN SAFETY AND PROTECTING GROUNDWATER



DRINKING WATER PROTECTION

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

Well Integrity ensures injected CO_2 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.

CO_2 IS MONITORED EVERY STEP OF THE WAY

REGIONAL CCUS ACTIVITY

~40 years of CCUS Operations
>1600 miles of CO_2 Pipeline
>176 million tonnes of CO_2 Stored*

*Tonnes stored as of Sept. 2025

Critical Challenges. Practical Solutions.

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THANK YOU

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