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The Plains CO₂ Reduction (PCOR) Partnership: Phase III Overview

Regional Carbon Sequestration Partnership Annual Peer Review Meeting

**Pittsburgh, Pennsylvania
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Energy & Environmental Research Center



The PCOR Partnership has brought together the key stakeholders to make geologic CO₂ sequestration a viable option for carbon management in our region.



Phase III Goals

- Meet or exceed our partners' expectations – develop a project that leads to commercial success.
- Develop:
 - Infrastructure and expertise that propagate the region's competitive advantage into the future.
 - Public support through outreach and education.
 - Practical industry standards for:
 - Site selection/permitting.
 - Risk assessment.
 - Monitoring, mitigation, and verification (MMV).
 - Markets and standards for the monetization of carbon credits.

Phase III Philosophy

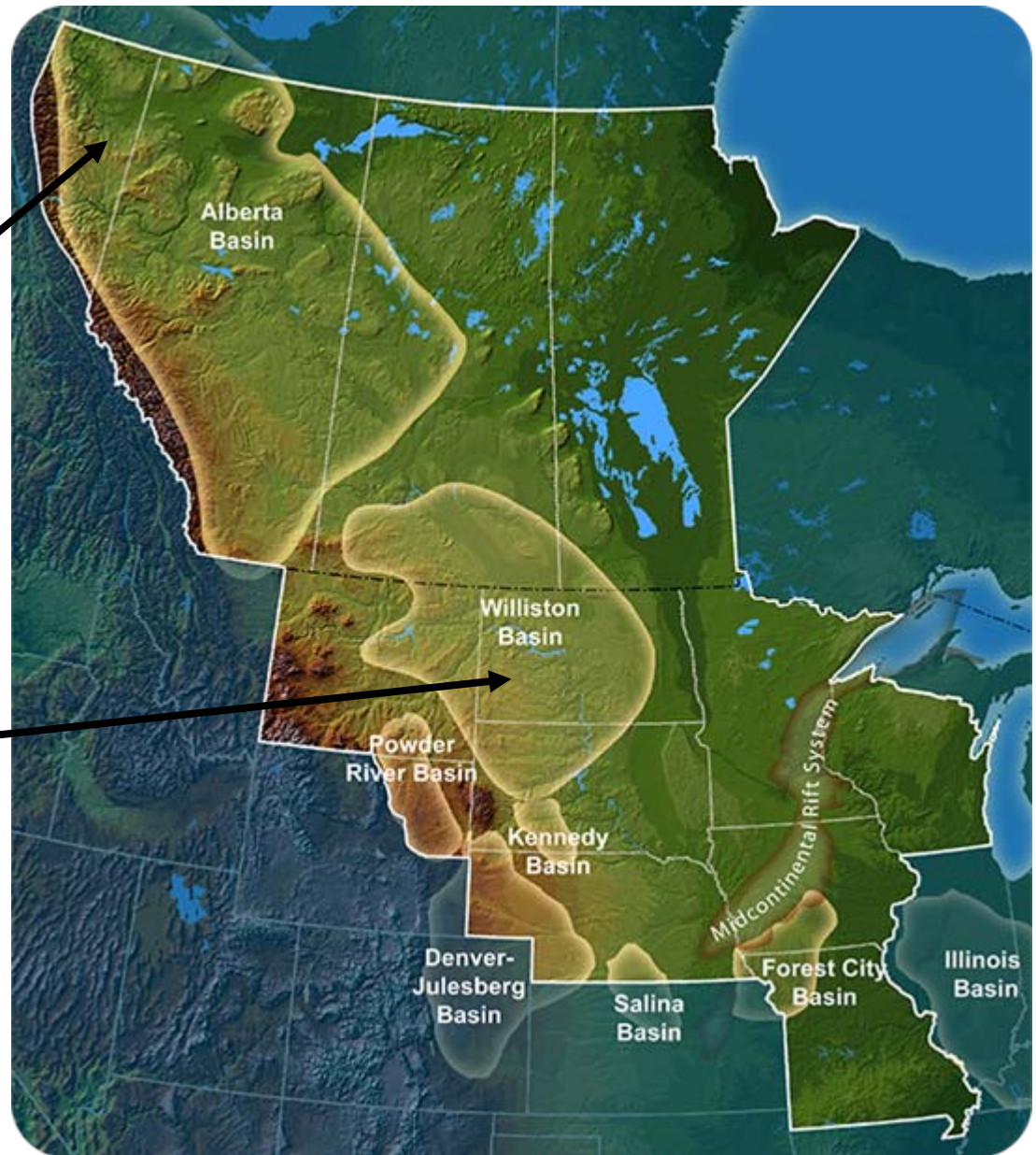
- There are two likely strategies for early adopters of carbon dioxide (CO₂) sequestration in our region:
 - Enhanced oil recovery (EOR) followed by saline injection.
 - Saline injection followed by EOR.
- EOR is a bridge technology for future large-scale implementation of CO₂ carbon capture and storage (CCS).
- There is a tremendous capacity for sequestration in PCOR Partnership region oil fields (30 billion tons).



Planning Two Phase III Efforts

Saline Formation
Injection in Canada

A Williston Basin
Project



Williston Basin Phase III – Concept

- Capture at least 1 million ton/yr of CO₂ at existing coal-fired power plant in central North Dakota.
- Transport via pipeline to Williston Basin oil field.
- Meet or exceed all of the U.S. Department of Energy (DOE) Phase III objectives.
- Conduct MMV activities to document integrity of storage.
- Ultimately monetize credits.



Why the Williston Basin?

- We have great Partners!
- The Williston Basin is perfect (both geologically and socioeconomically) for this demonstration.
- Potential to be one of the first commercial-scale projects to capture CO₂ from a retrofitted conventional coal-fired power plant.
- Develop supporting evidence for the hypothesis that effective MMV need not be intrusive to field operations nor expensive to implement.

Dakota Gasification Company

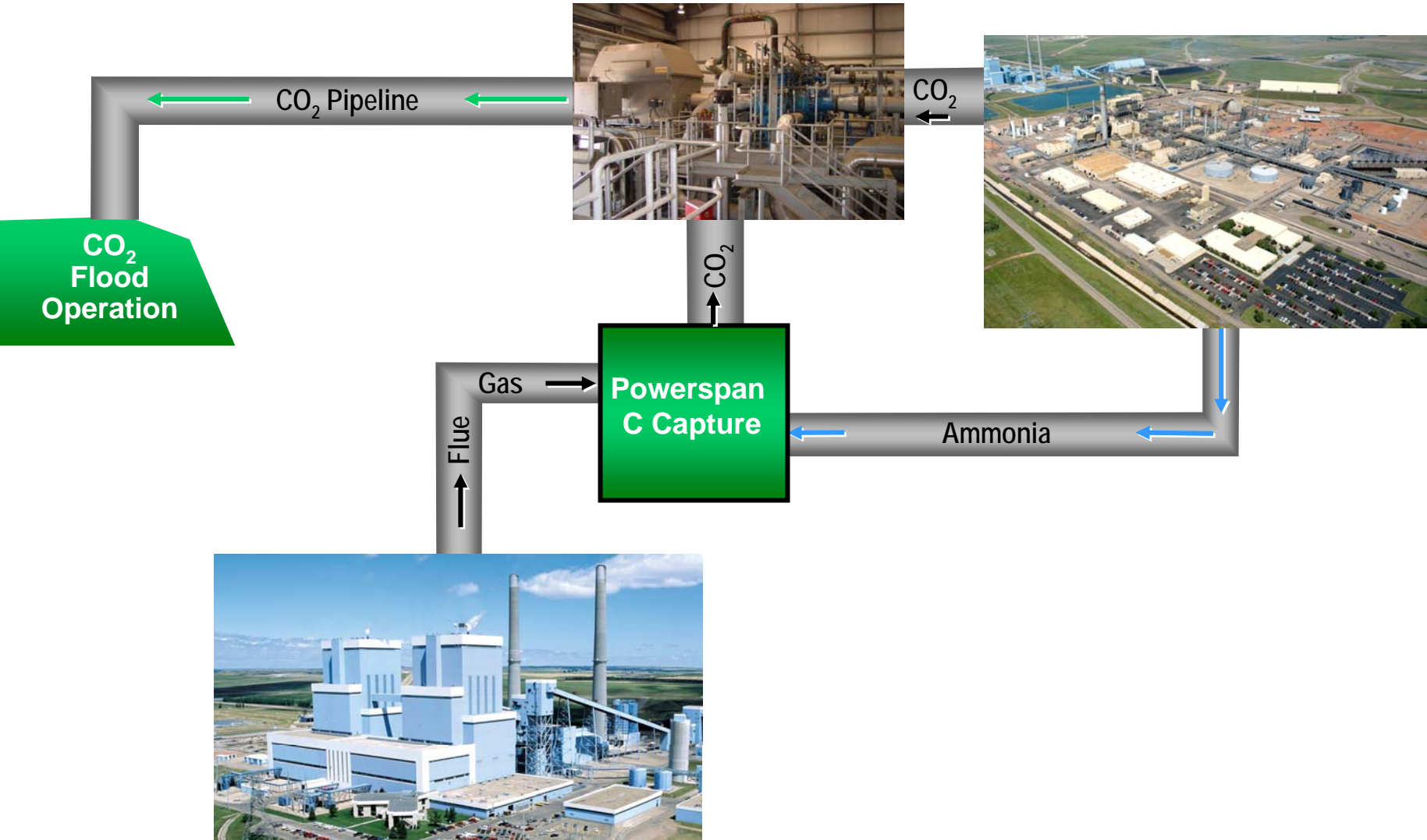
Commercial-scale Carbon Sequestration Project

Weyburn, Saskatchewan

- 13 million tons sequestered to date



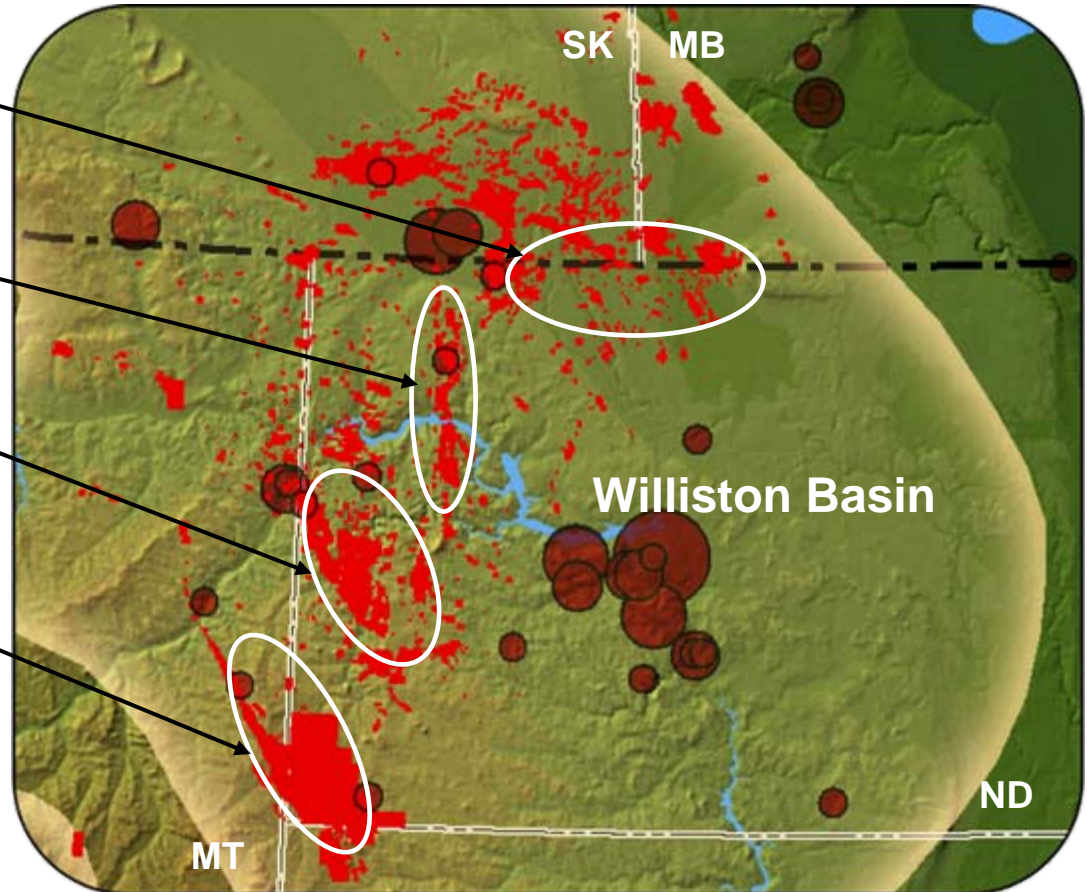
Carbon Capture Demonstration Project



Williston Basin Oil Field EOR

- There are several major areas of opportunity for million ton/year CO₂-based EOR projects in the Williston Basin:

- Northeast Flank
50 MMcf/day
(~1,000,000 t/year)
- Nesson Anticline
100 MMcf/day
(~2,000,000 t/year)
- Billings–Dickinson Area
50 MMcf/day
(~1,000,000 t/year)
- Cedar Creek Anticline
400 MMcf/day
(~8,000,000 t/year)

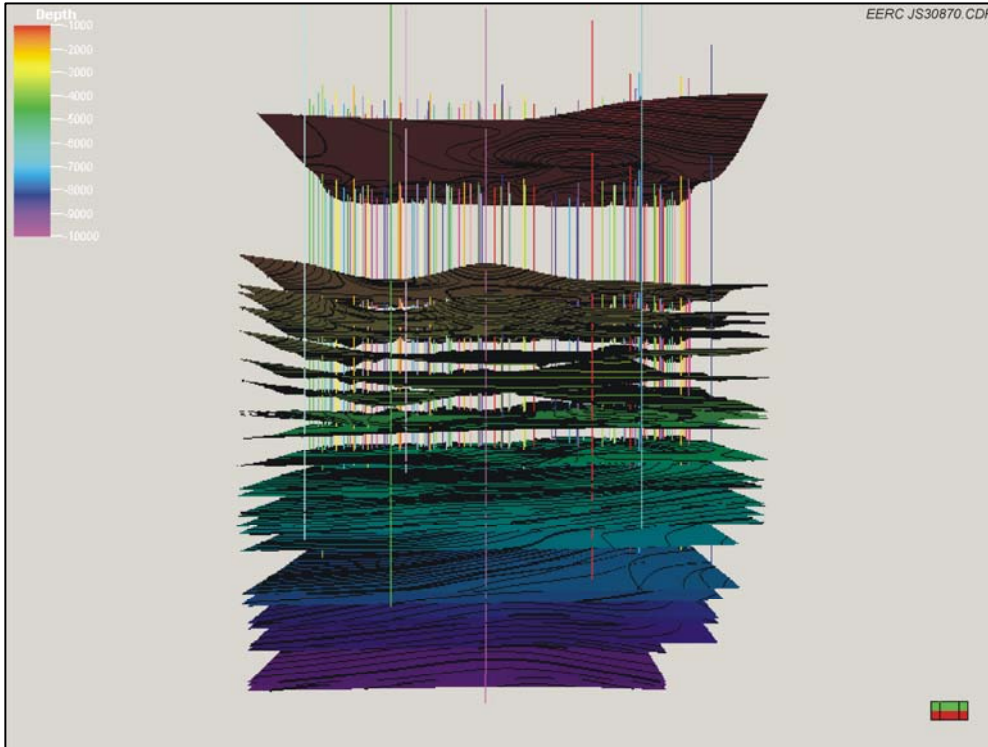


Monitoring CO₂ Sequestration – Partner Relationships

- Need to coordinate and integrate our activities with ongoing and planned power plant and oil field operations.
- Data deemed by operating partner to provide competitive advantage may not be available.



Williston Basin Stratigraphy



Petrophysical modeling of sealing formations in the Williston Basin based on well log data, geophysical data, and core data from North Dakota Department of Mineral Resources – Oil & Gas Division and commercial data vendors.

Age Units	YBP (Ma)	Rock Units (Groups, Formations)	
		USA (ND)	Canada (SK)
Cenozoic	Quaternary	White River Fm Golden Valley Fm	Wood Mountain Fm
	Tertiary	Fort Union Grp	Ravesrag Fm
Mesozoic	66.5	Hell Creek Fm	Frenchman Fm
		Fox Hills Fm	Wilmot Fm
		Pierre Fm	Eastford Fm
		Judith River Fm	Pierre Fm
		Eagle Fm	Beaupaw Fm
		Nobara Fm	Judith River Fm
		Carlile Fm	Milk River Fm
		Greenhorn Fm	Fort White Speckled Shale
		Belle Fourche Fm	Nobara Fm
		Mowry Fm	Carlile Fm
Phanerozoic	144	New Castle Fm	Second White Specks
		Skull Creek Fm	Belle Fourche Fm
		Hyman Kara Grp	Fall Creek Fm
		Swift Fm	Westgate Fm
		Rierdon Fm	Viking Fm
		Piper Fm	Joli Fou Fm
		Spearfish Fm	Mannville Group
		Mesa Verde Fm	Sucess Fm
		Opeche Fm	Masefield Fm
		Broom Creek Fm	Rierdon Fm
Paleozoic	248	Amnsden Fm	Upper Watrous Fm
		Tyler Fm	Lower Watrous Fm
		Over Fm	Missing
		Kibby Fm	Missing
		Charles Fm	Missing
		Mission Canyon	Missing
		Lodgepole Fm	Missing
		Bakken Fm	Charles Fm
		Interlake Fm	Poplar Mbr
		Stonewall Fm	Packline Mbr
Paleozoic	360	Winnipeg Fm	Middle Mbr
		Red River Fm	Missoua Fm
		Winnipeg Fm	Fossilifer Mbr
		Winnipeg Fm	Albia Mbr
		Winnipeg Fm	Thelon Mbr
		Winnipeg Fm	Scotts Valley
		Winnipeg Fm	Bakken Fm
		Winnipeg Fm	Big Valley Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
Paleozoic	436	Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
Paleozoic	498	Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
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		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
Paleozoic	505	Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
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		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
Paleozoic	590	Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
		Winnipeg Fm	Winnipeg Fm
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Seal Fm

Oil Producing Fm

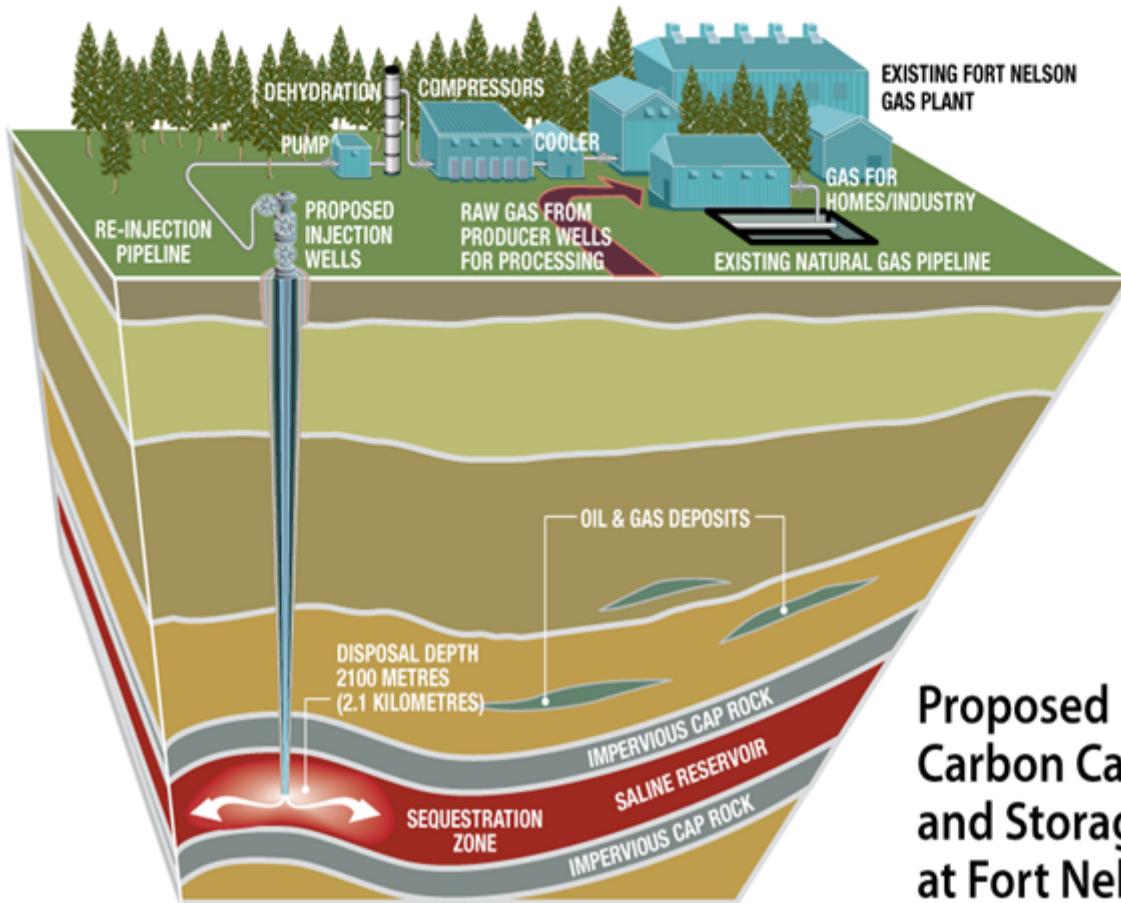
Fort Nelson Carbon Capture and Sequestration in a Deep Saline Formation



Spectra Energy
Transmission

*Fort Nelson Gas Plant,
British Columbia,
Canada*

Fort Nelson CCS Project



Proposed
Carbon Capture
and Storage
at Fort Nelson

Major Features:

- Deep saline sequestration at 7000 to 8000 ft deep to maximize storage capacity
- Inject and permanently store 1 to 2 Mt/yr CO₂
- Fort Nelson gas plant owned 100% by Spectra Energy
- Tenure to deep saline formations of interest are obtained

Why Fort Nelson?

- Satisfies DOE desire to participate in a demonstration of CCS of 1 million ton/year in a saline formation.
- The project will result in the establishment of relevant, cost-effective MMV protocols for saline formation CCS that can be applied throughout the world.
- International nature of the project is a positive.
- The efficient and streamlined nature of the key elements will likely lead to a rapid deployment.



Thank You!



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