

Wyoming CarbonSAFE: Accelerating CCUS Commercialization and Deployment at Dry Fork Station and the Wyoming Integrated Test Center

PROJECT AWARD #: DE-FE0031891

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U.S. Department of Energy

National Energy Technology Laboratory

Carbon Management Project Review Meeting

August 28 – September 1, 2023

CARBON TRANSPORT AND STORAGE SESSION 1

Tuesday 1:35pm



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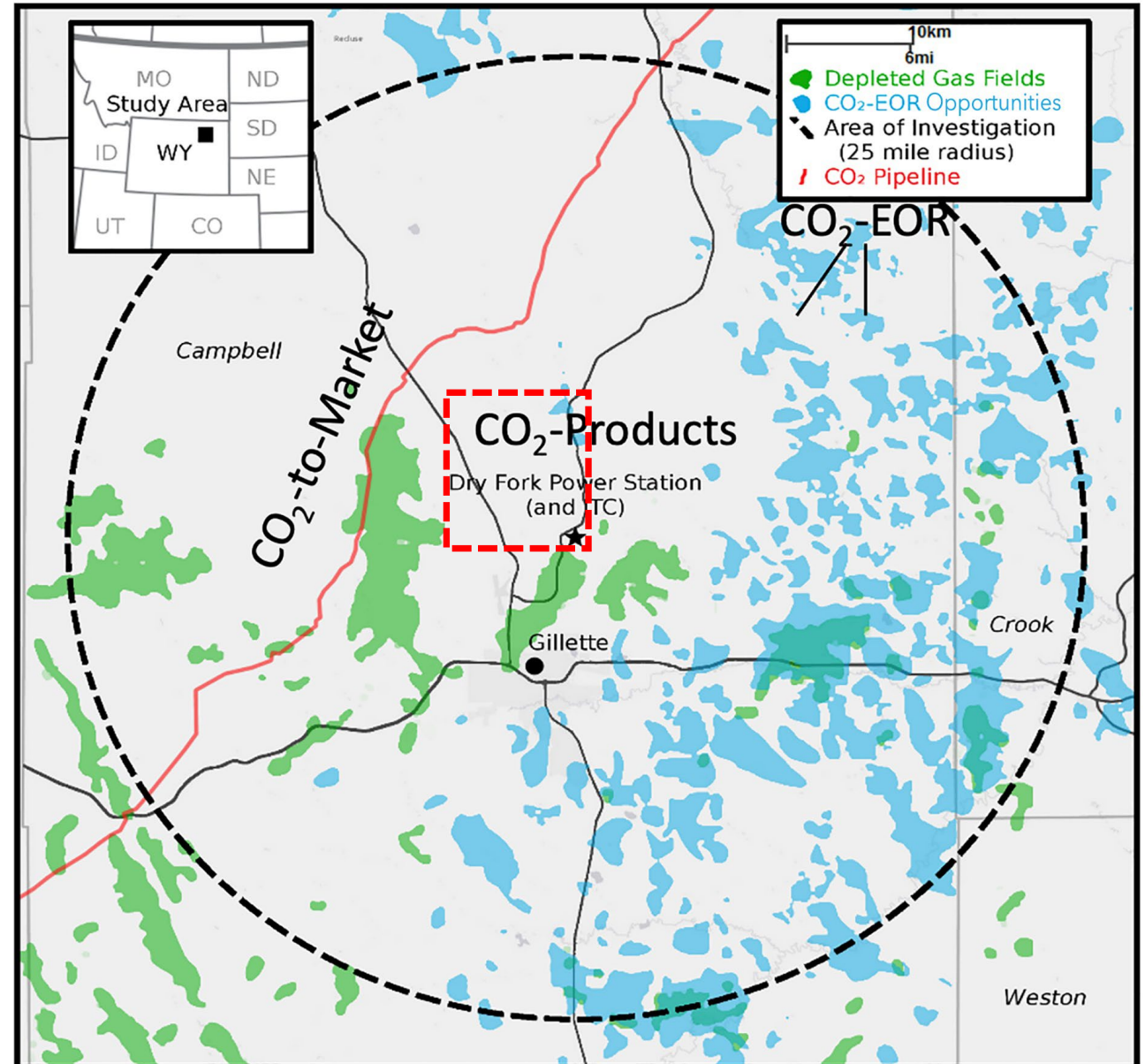
THE WORLD NEEDS MORE COWBOYS.

Project Overview

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Site Background

- Modern coal plant with 50+ year operational life-span
- Located adjacent to:
 - Existing intrastate CO₂ transportation network
 - Multiple utilization industries
 - Carbon to products industry
 - CO₂-EOR for carbon utilization
 - Experienced carbon workforce
 - Multiple CO₂ point sources
 - Transportation infrastructure
- Wyoming has:
 - CO₂ management legislative and gov't framework
 - Class VI primacy
 - Long-term CCUS liability fund
 - Educated and supportive public
 - Known geologic targets



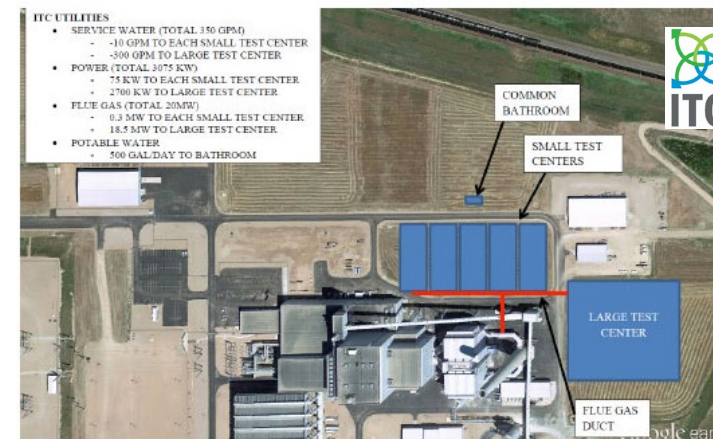
Project Overview: Wyoming CarbonSAFE Phase III

Dry Fork Station

- Built in 2007
- Operating life to 2072
- 385 MW
- 3.3 million tons of CO₂/year

WY-Integrated Test Center (ITC)

- Completed fall 2017
- Test CO₂ capture/CCUS technologies
- \$20M public/private investment
- Multiple Capture awards led by Membrane Technology Research (MTR) Large-scale pilot



WYOMING
INTEGRATED
TEST CENTER

Wyoming CarbonSAFE Storage Site



Photo courtesy of Dave Green, Western Fuels



UW PRB#1

UW PRB#2

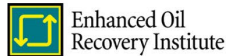
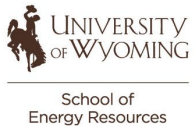
Photo courtesy of Google Earth

Project Participants



ACADEMIC PARTNERS

University of Wyoming
Advanced Resources International
Energy and Environmental Research
Center
Los Alamos National Laboratory



CARBON CAPTURE

Membrane technology and
Research, Inc. (MTR)
Wyoming Integrated Test Center



INDUSTRIAL PARTNERS

Basin Electric Power Cooperative
Schlumberger Carbon Services
Denbury Resources
Oxy Low Carbon Ventures
Carbon GeoCapture
Western Fuels Association
Wyoming Municipal Power Agency



PERMITTING, ENVIRONMENTAL AND REGULATORY EXPERTS

Long Reimer Winegar Beppler, LLP
TriHydro Corporation
Wyoming Energy Authority
Wyoming Department of
Environmental Quality (DEQ)



Major Objectives

1. Finalize surface and subsurface characterization activities at DFS
2. Conduct NEPA and environmental analysis
3. Integrate MTR's CO₂ FEED capture assessment
4. Complete Class VI permits to construct for the Wyoming CarbonSAFE storage hub

Project funding:

- \$15,526,325 (Federal)
- \$3,941,389 (Cost share)
- \$19,467,714 (Total)



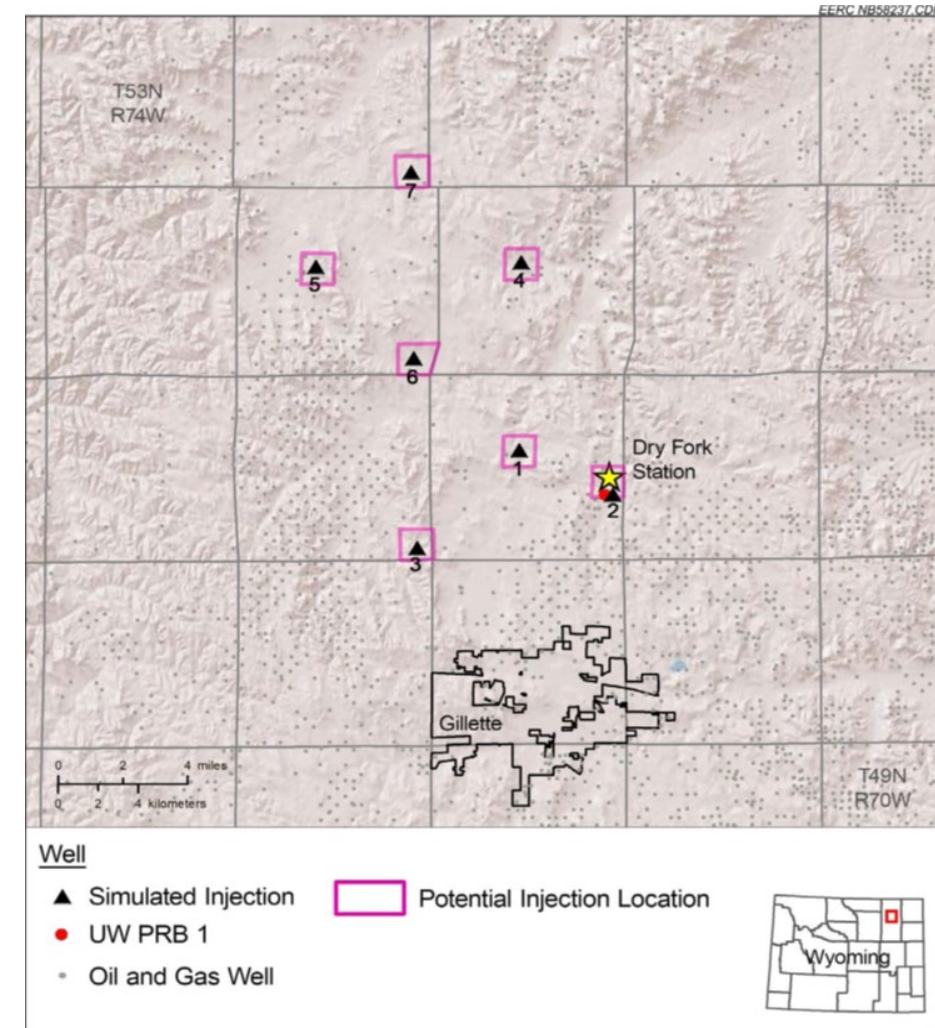
Technical Approach

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Technical Approach

Technical Approach for Site Characterization and Commercialization of the Wyoming CarbonSAFE Storage Hub

- Characterize seven sites within the storage hub
- Full injection/permitting completion of the DFS site
 - 2 wells to optimize stacked storage, tests and subsurface data gap completion
 - Wells constructed to Class VI standards
- Develop and complete Class VI permits
- Develop business and commercial strategies for the storage hub
- Environmental assessment (NEPA) and baseline site conditions
- Integrate MTR's capture assessment into the commercial plan
- Finalize site risk and MVA
- Develop greater regional capacity than the program requires



Site Characterization

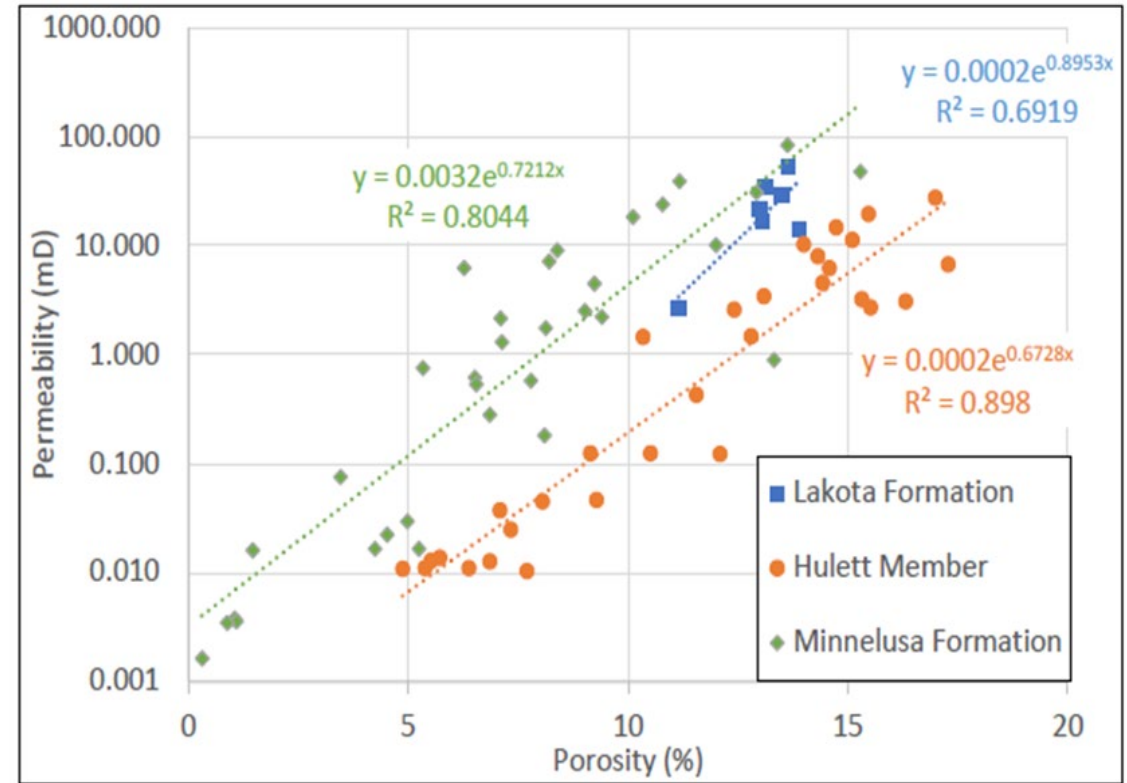
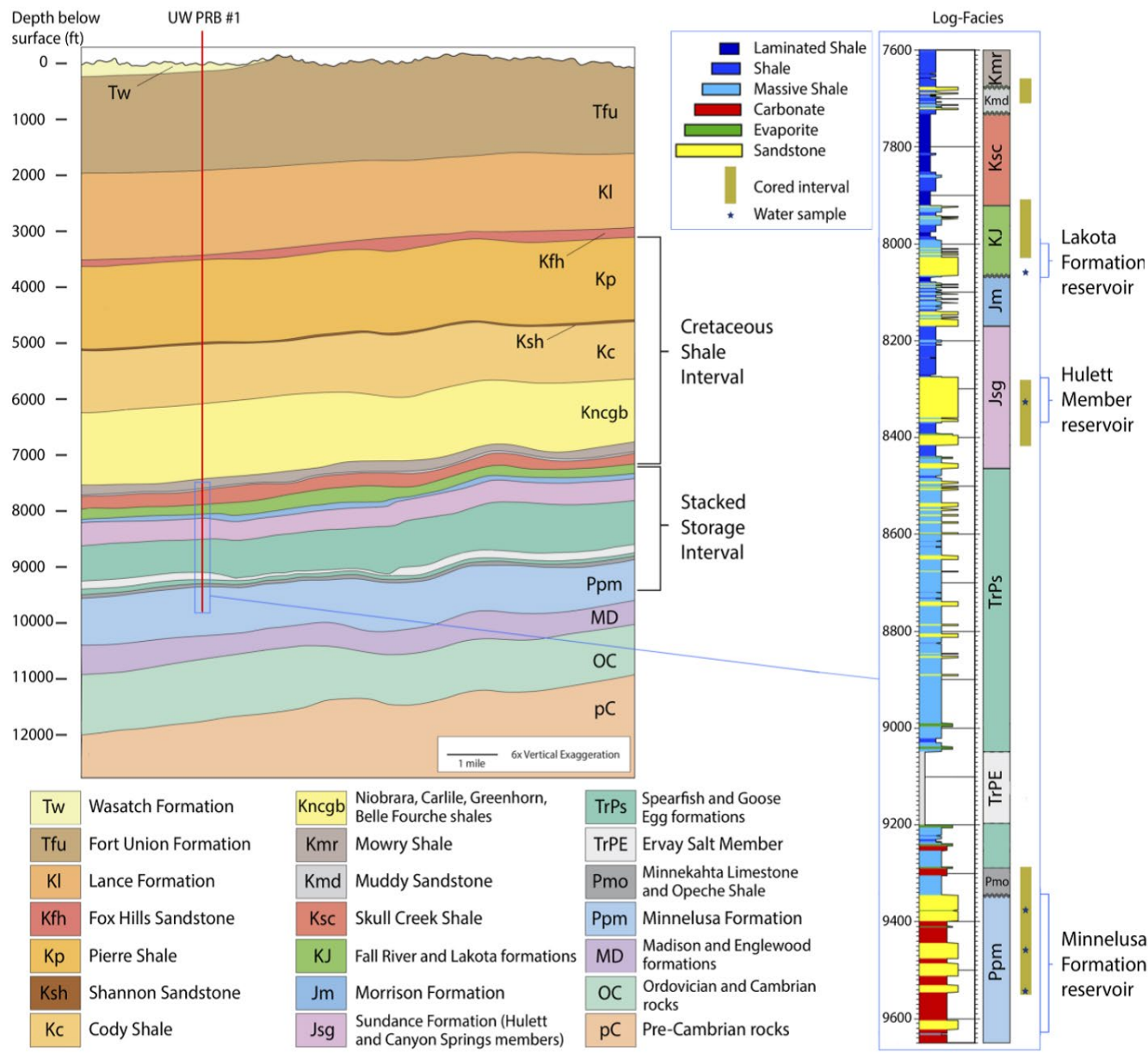
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Site Characterization To-date

- Two test well completed (UW PRB#1 and UW PRB#2) sampled and analyzed
- Environmental and monitoring assessments; soil, groundwater and passive seismic
- New 3D seismic survey and legacy 2D seismic data
- Storage hub property models and injection feasibility simulations
- Regulatory assessments
- Economic/business case assessments
- NEPA assessments; EIV completed and EA in-progress
- Initial risk and MVA assessments

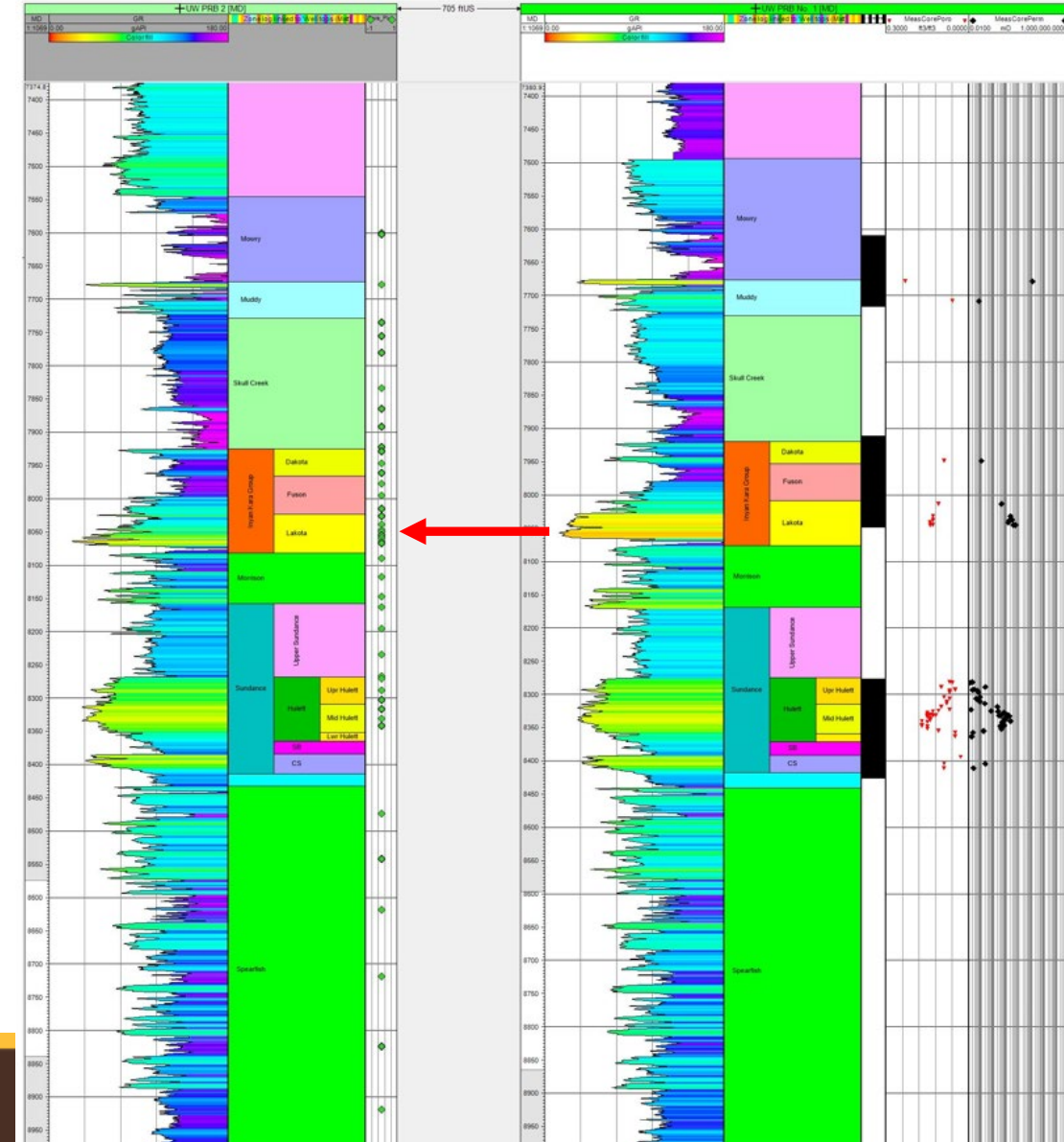


Site Characterization To-date



Site Characterization To-date

Well to well assessment



Status Update

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Status Update

Carbon Capture: Membrane Technology Research FEED And Large-Scale Capture Pilot



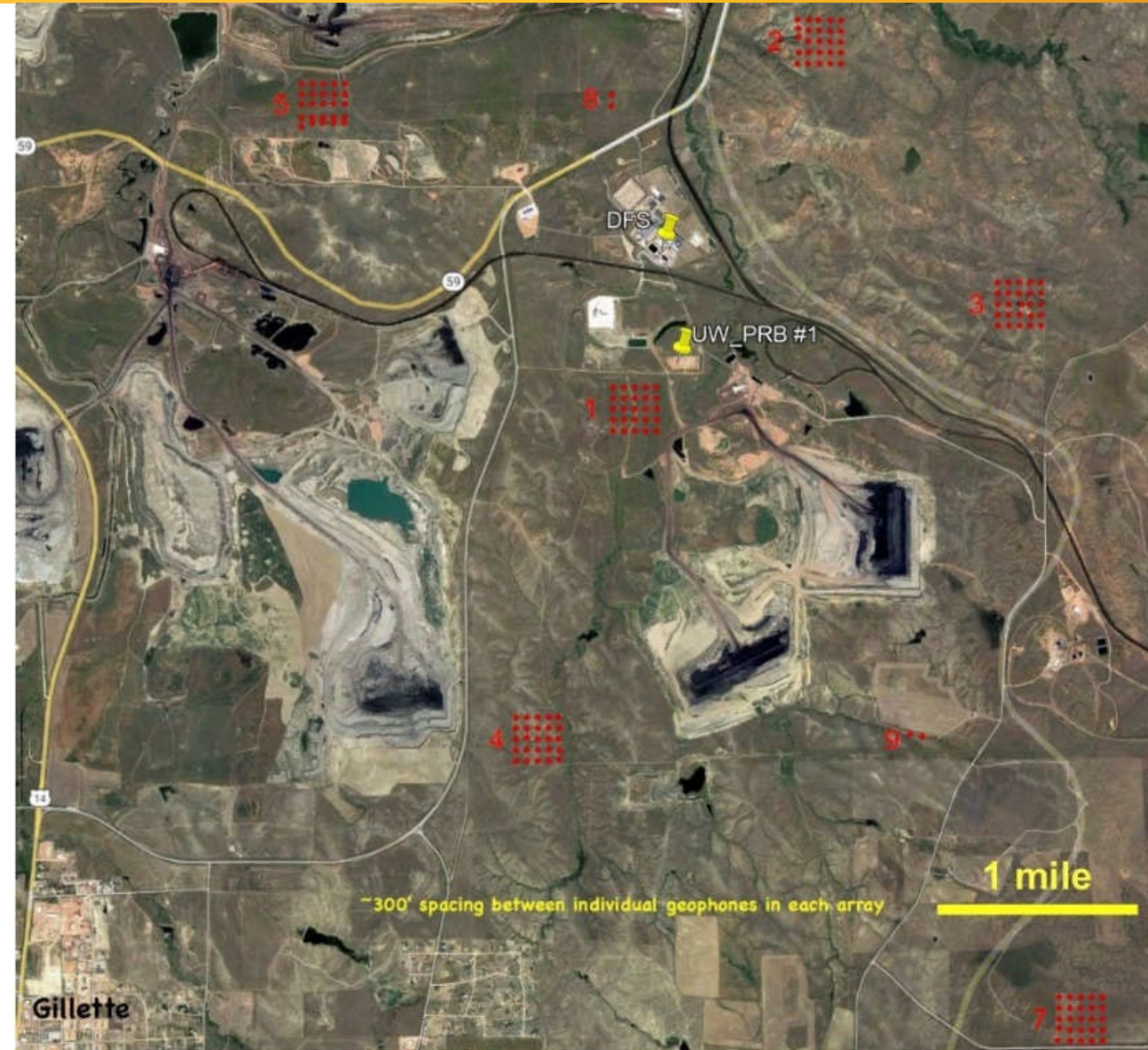
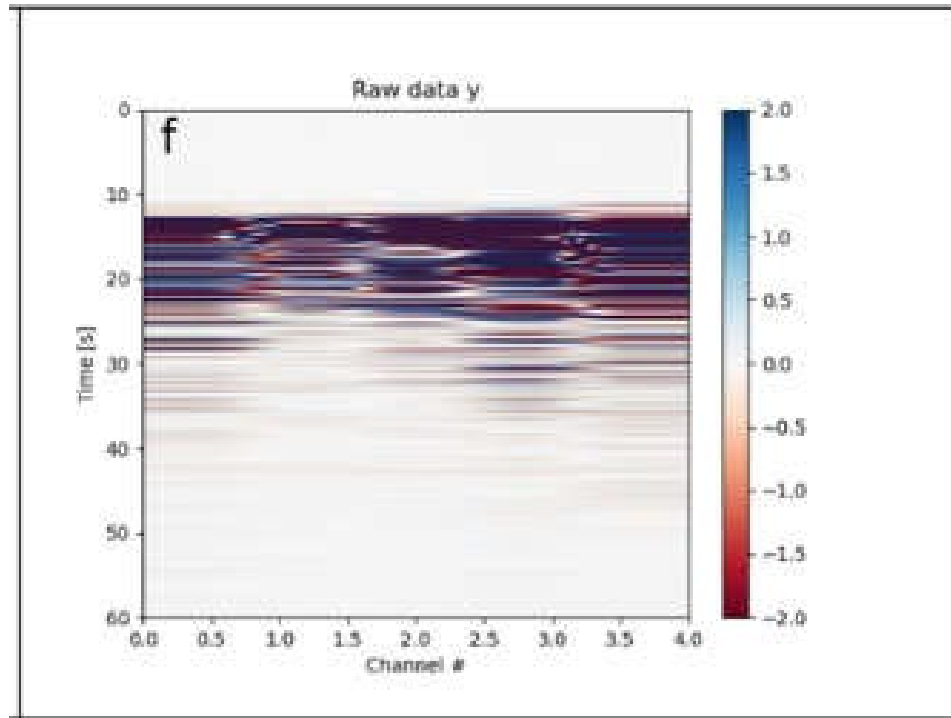
July 24, 2023



Status Update

Regional Seismicity

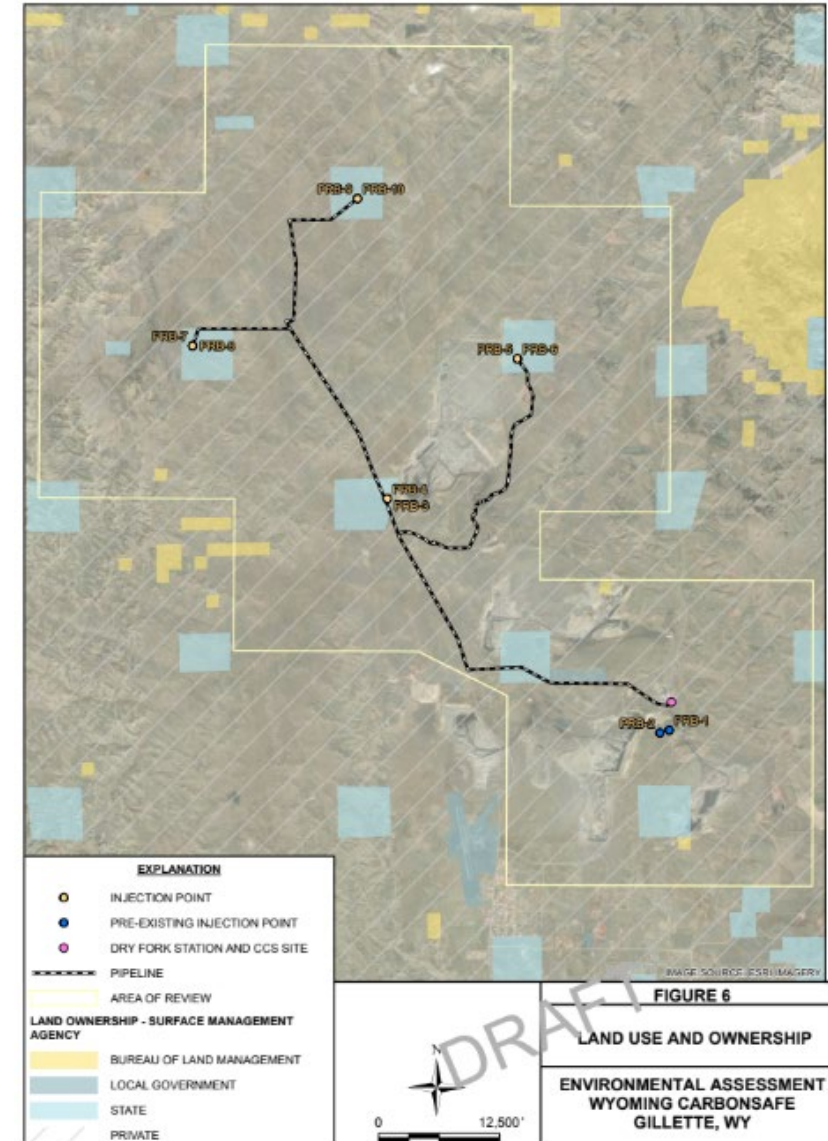
- Over two years of monitoring data
- Background seismicity established
- New technologies tested



Status Update

NEPA Assessment and Permitting

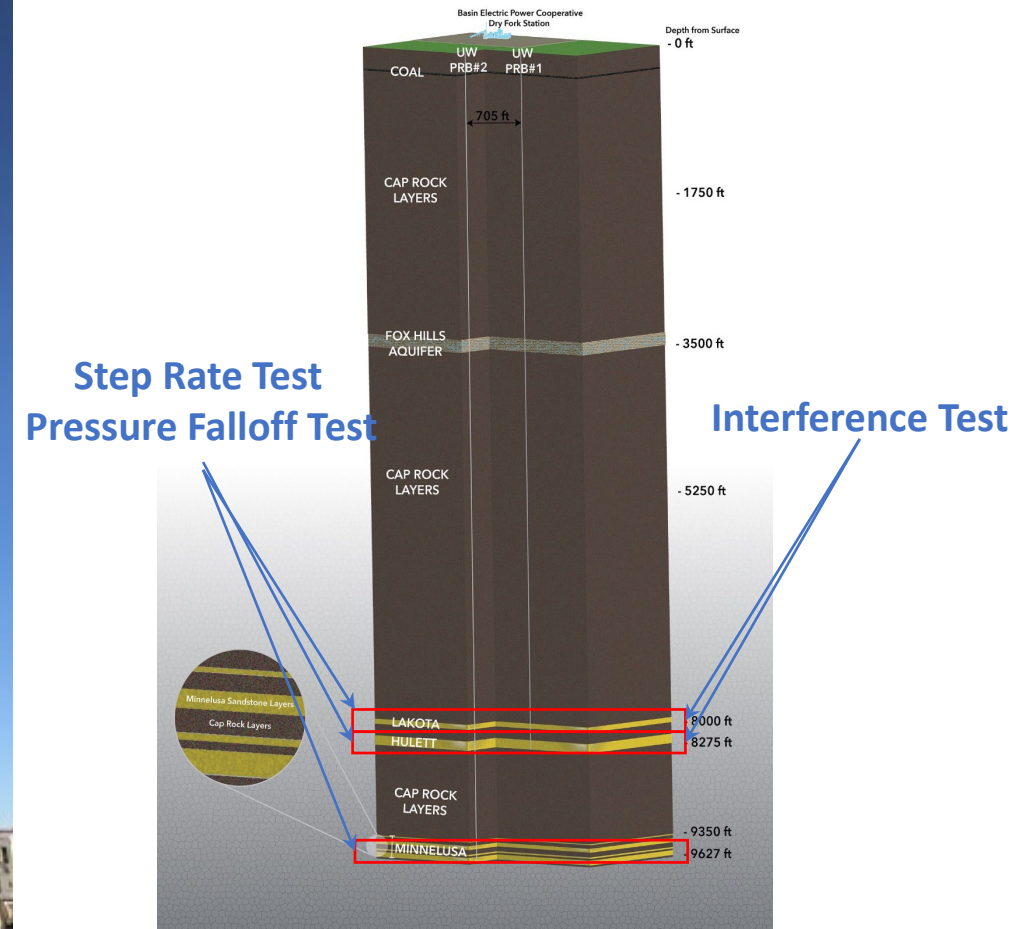
- Currently in Draft phase
- First of its kind for a CCS project in Wyoming
- Currently assessing 10 Class VI permits
- Class VI permits in-Draft phase



Status Update

2022-2023 Field Testing Program

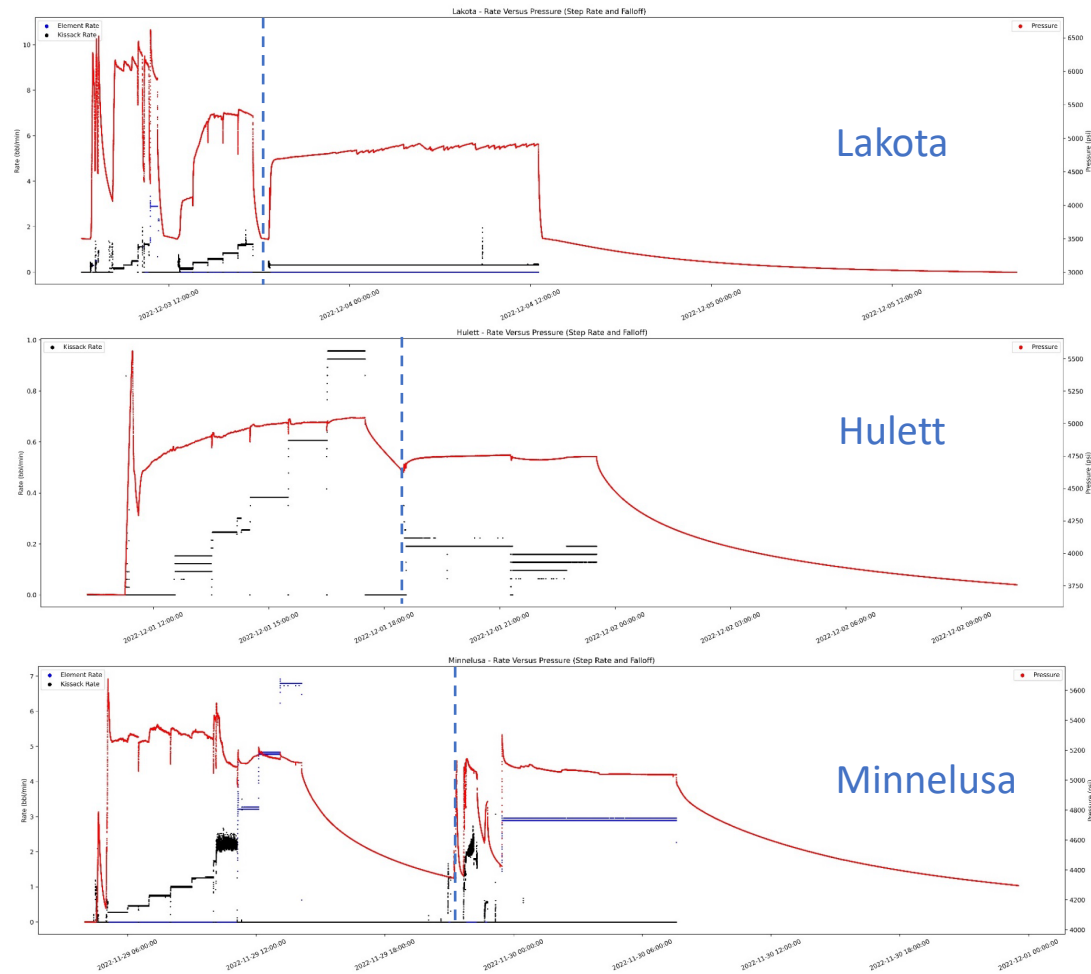
- Crosswell Tomography
- In-situ Geomechanical and Interference Tests



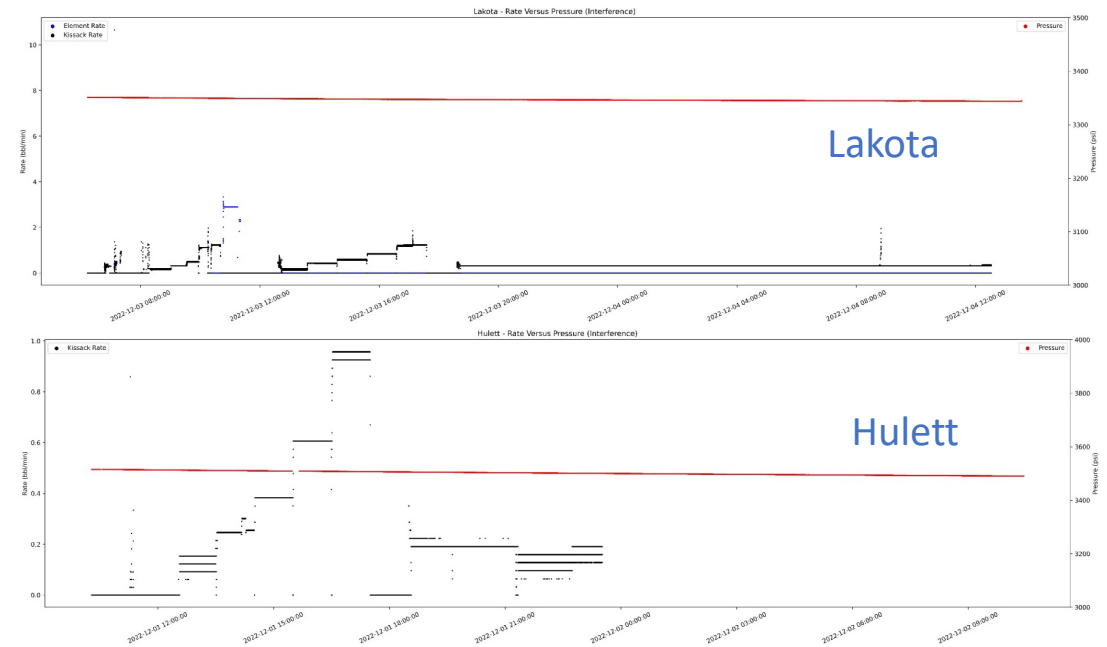
Status Update

Field Data

Step Rate Test and Pressure Falloff Test



Interference Test



Status Update

Results interpreted from the test conducted at the Hulett Sandstone

Table 6.1.4 Results interpreted from the test conducted at the Hulett formation

Perforation Depth	ft	8309 - 8361 (MD)
Gauge Depth	ft	8259 (MD)
Initial Reservoir Pressure (from MDT)	psi	3315.75 (@ 8330.34 ft MD)
Pore Pressure Gradient	psi/ft	0.398
Formation Fracture Gradient	psi/ft	0.598
Permeability	md	0.115 ~ 0.158
Pay Zone	ft	52
Fracture Half Length	ft	47.968 ~ 56.209
Skin Factor	-	-4.284 ~ -2.55
Radius of Investigation	ft	36.356 ~ 42.602
Wellbore Storage Coefficient	bbl/psi	0.0014

Status Update

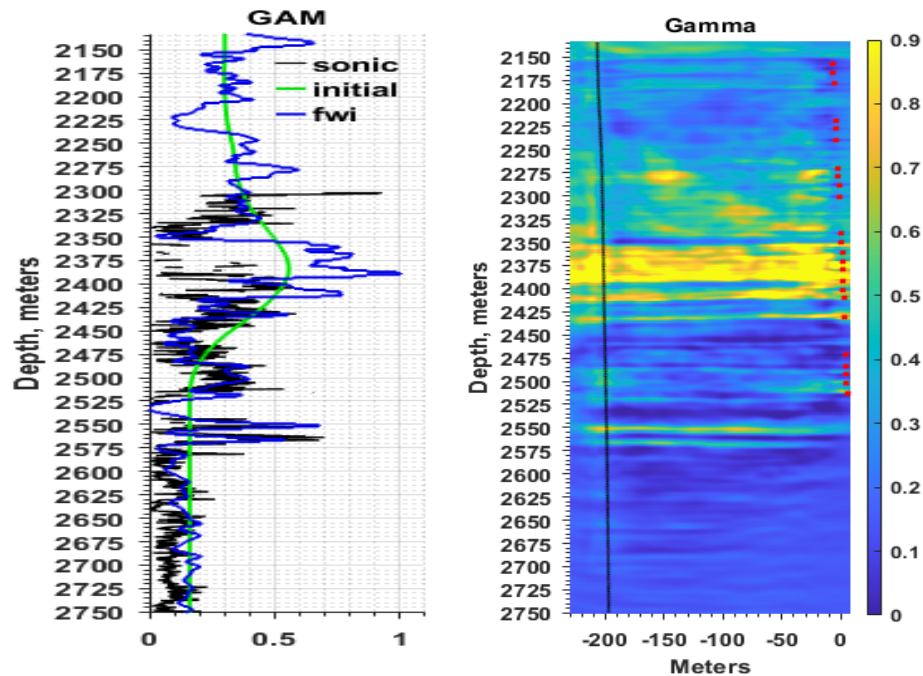
Results interpreted from the test conducted at Lakota Sandstone

Table 6.1.5 Results interpreted from the test conducted at the Lakota formation

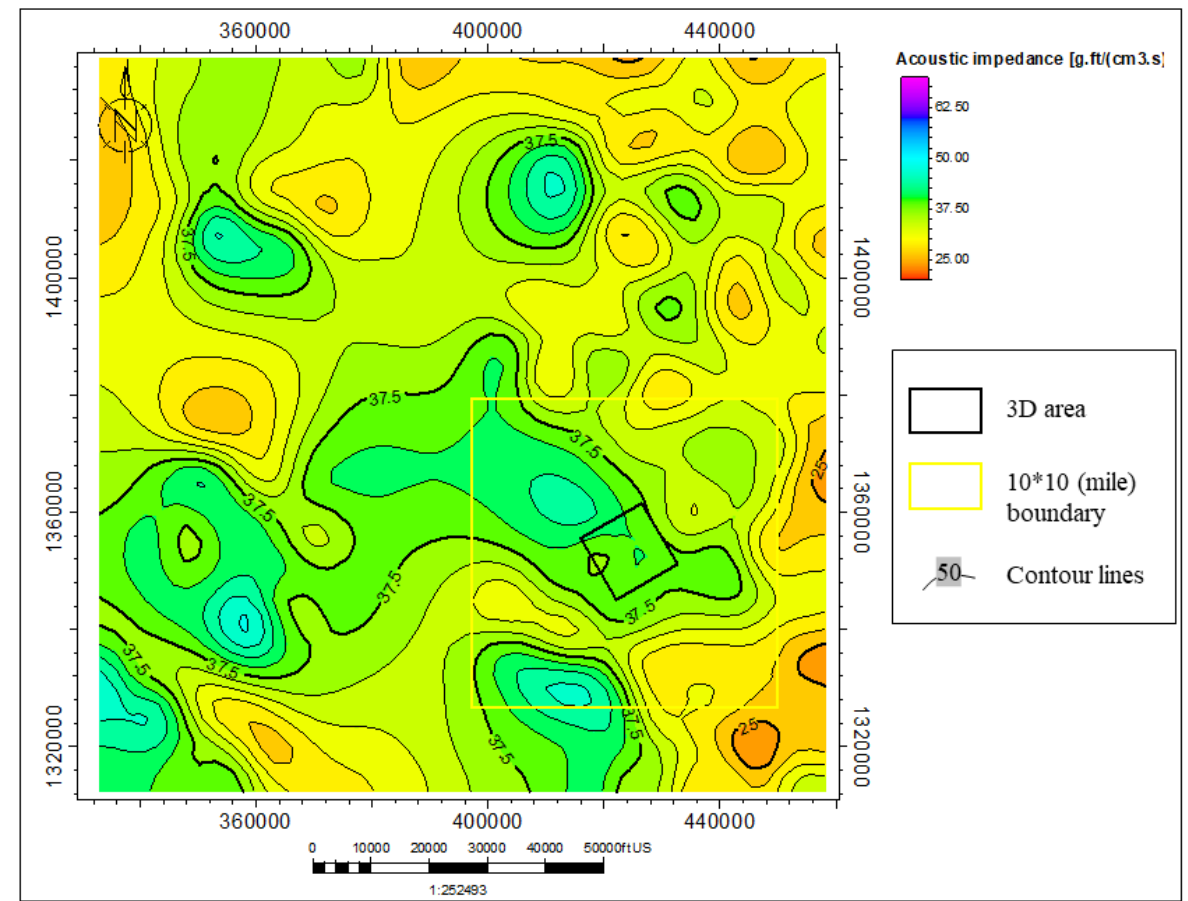
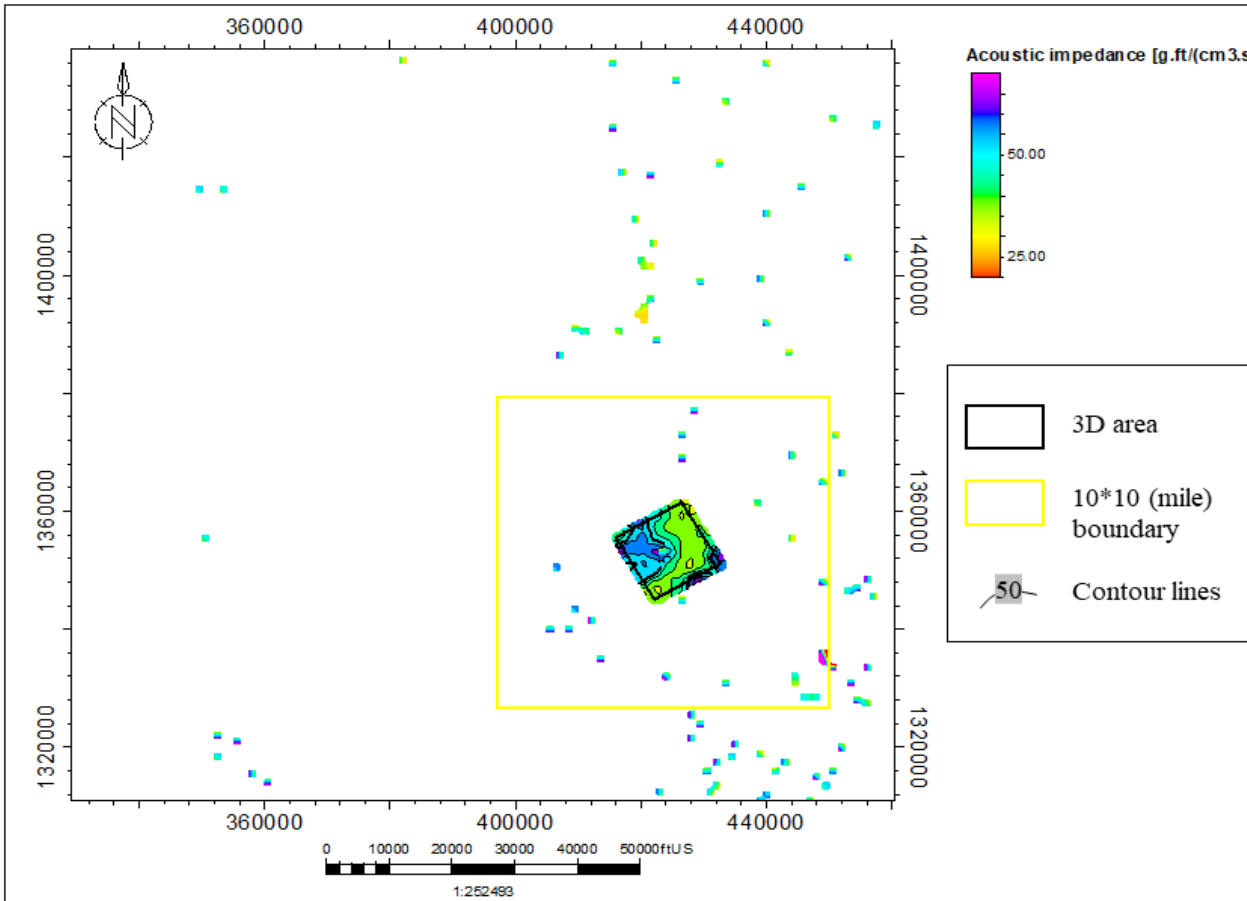
Perforation Depth	ft	8051 - 8071 (MD)
Gauge Depth	ft	8000 (MD)
Initial Reservoir Pressure (from MDT)	psi	2965.10 (@ 8065.02 ft MD)
Pore Pressure Gradient	psi/ft	0.368
Formation Fracture Gradient	psi/ft	0.659
Permeability	md	3.082 ~ 14.498
Pay Zone	ft	20
Skin Factor	-	0.134 ~ 5.421
Radius of Investigation	ft	183.706 ~ 375.38
Wellbore Storage Coefficient	bbl/psi	0.0012→0.373 / 0.0018→0.014

Status Update

Crosswell Seismic Survey



Status Update

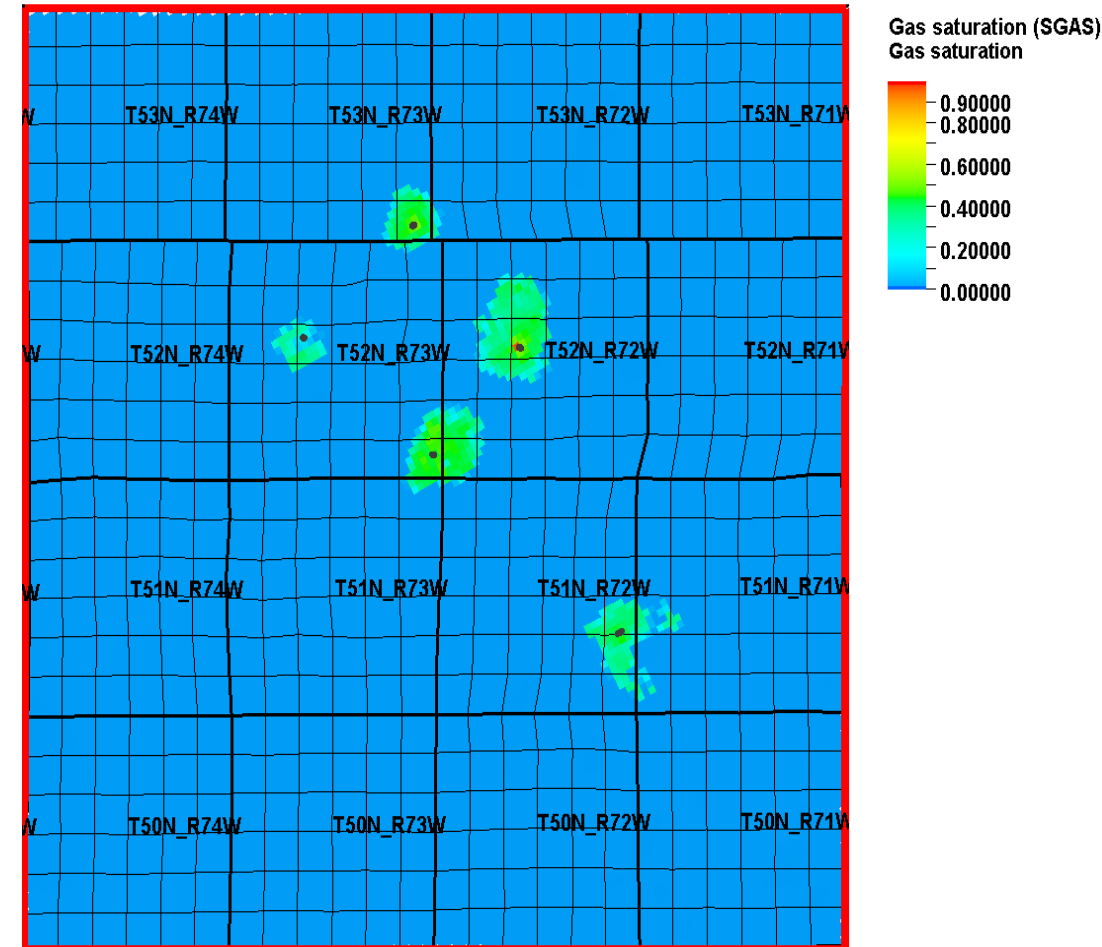


Average impedance map for Lakota

Status Update

Pad	Lakota		Hulett		Minnelusa	
	Plume Size (acre)	Cumulative CO ₂ Injected (million tonne)	Plume Size (acre)	Cumulative CO ₂ Injected (million tonne)	Plume Size (acre)	Cumulative CO ₂ Injected (million tonne)
1	2056.17	2.6	64.02	0.19	1361.98	3.32
2	1460.19	2.89	1886.1	4.07	975.81	3.6
3	326.26	0.45	990.52	2	3261.78	8.87
4	966.47	1.44	477.99	0.78	2301.07	4.53
5	2153.51	7.88	39.28	0.3	2447.82	9.58
Total	6962.6	15.26	3457.91	7.34	10348.46	29.9
Maximum Plume Size (acre)	11,953					
Total Cumulative CO ₂ Injected (million tonne)	52.5					

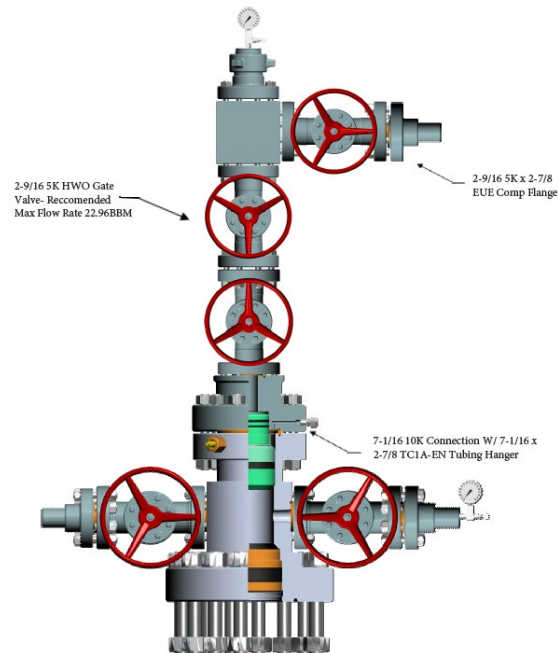
Minnelusa (12 Years of Injection)



Status Update

Well Status

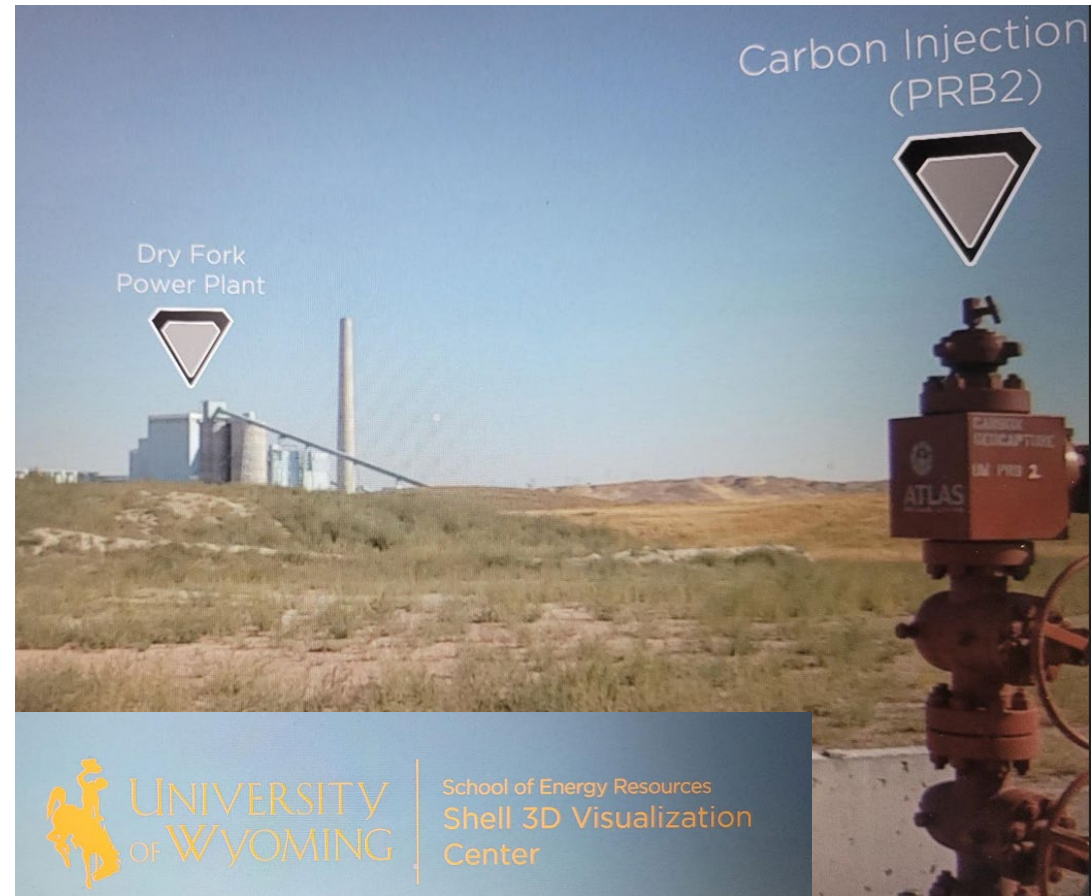
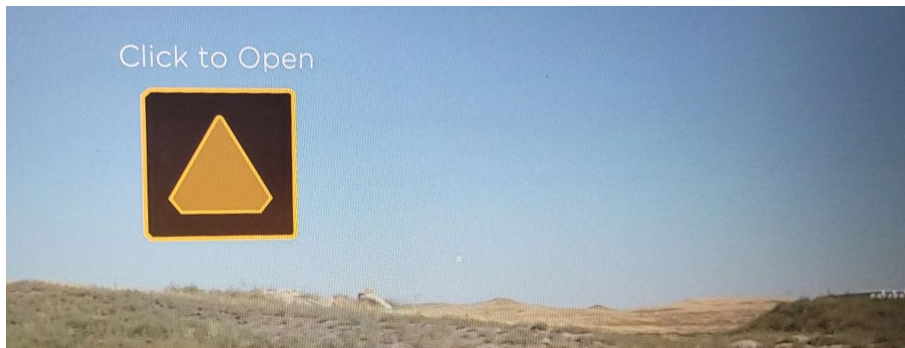
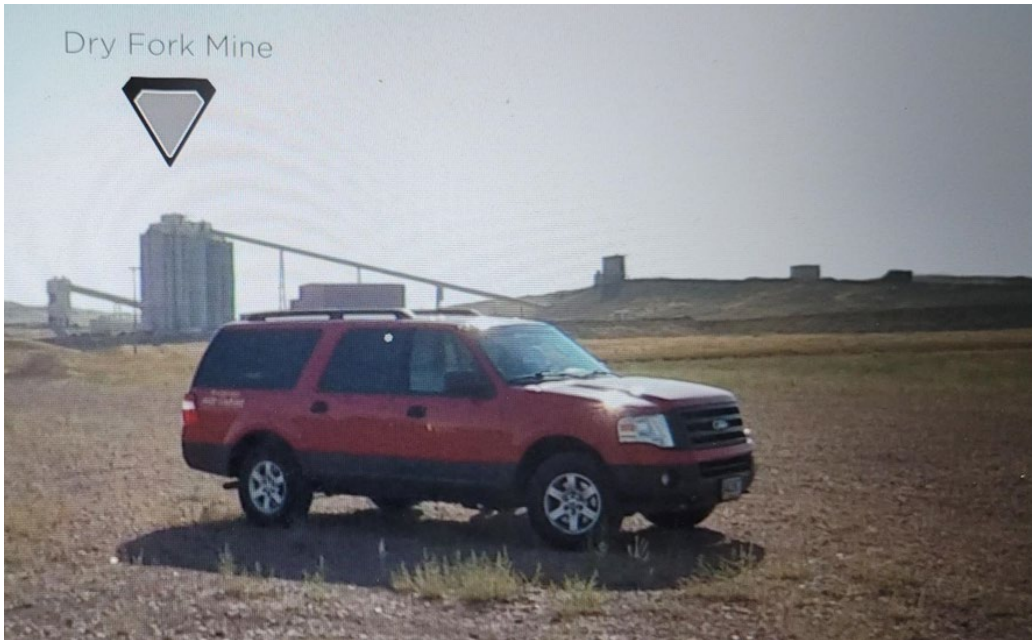
- Both UWPRB#1 and #2 are constructed
- Construction and field reviews are underway



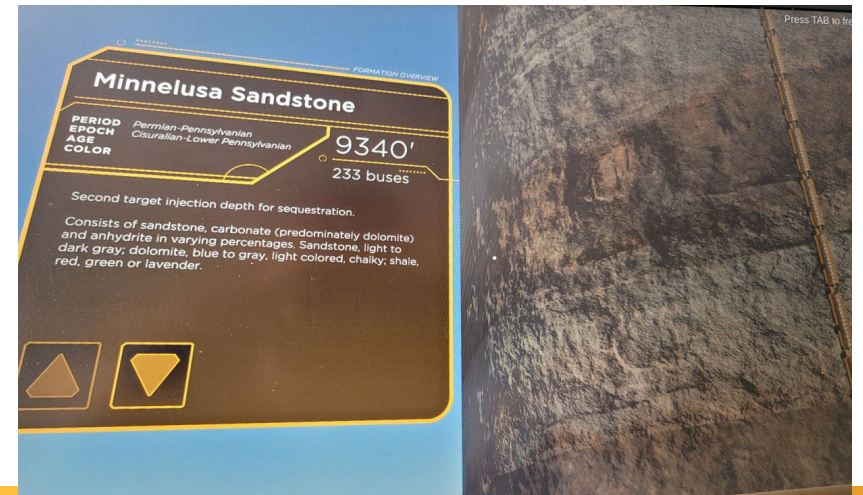
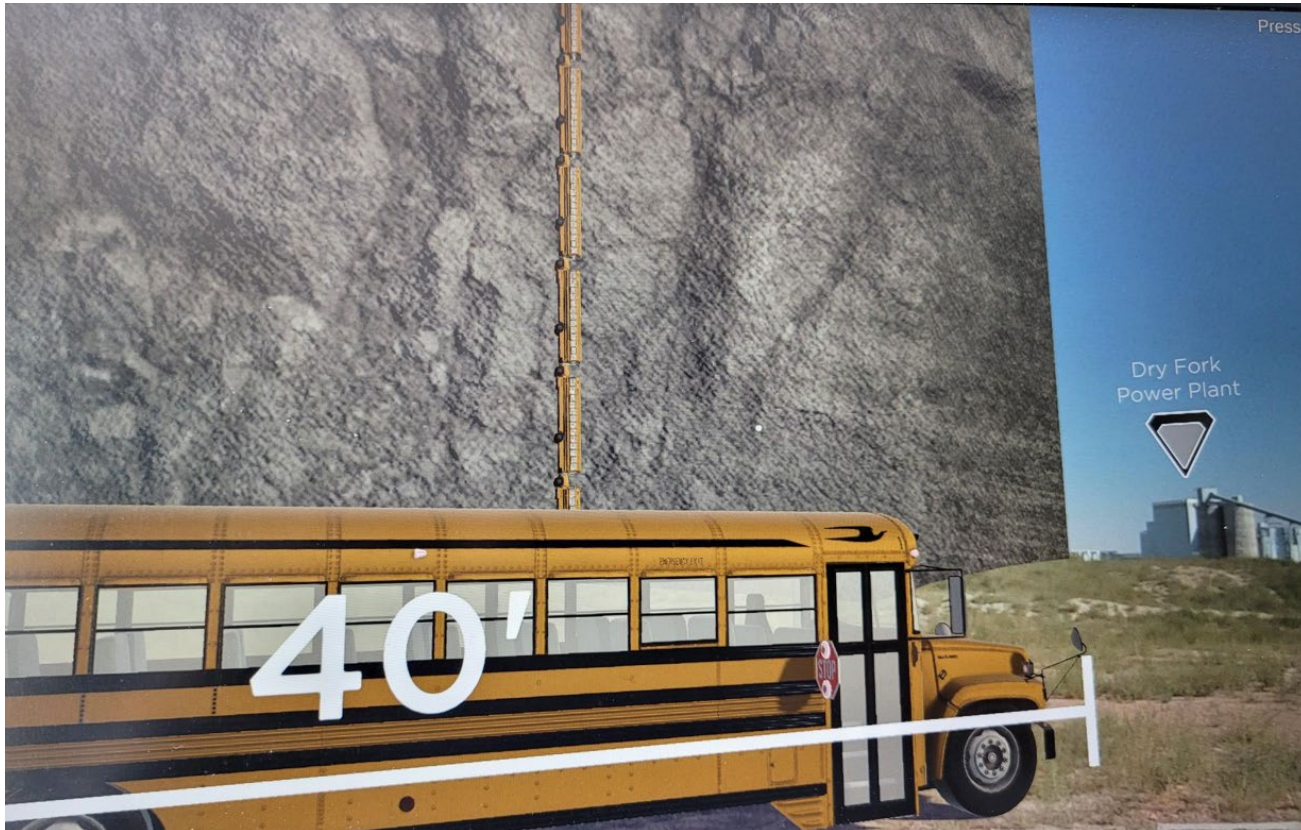
Outreach and Engagement

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Tools for public engagement



Tools for engagement



Other engagement highlights

CarbonSAFE: Onshore Legal and Regulatory Workshop



May 22-23, 2023
BP Collaboration Room
Energy Innovation Center
University of Wyoming



WHAT EVERY WYOMING LANDOWNER SHOULD KNOW ABOUT CARBON CAPTURE AND STORAGE

A CCS RESOURCE GUIDE AND
FREQUENTLY ASKED QUESTIONS

By Carson Tanner, J.D/M.A.
& Tara Righetti, Professor of Law and Occidental
Chair for Energy and Environmental Policies
2023



EPA Administrator Regan visits SER
and Dry Fork Station



RECS Research Experience Carbon Storage

Next Steps

- Currently working through time and cost growth for the project to meet Phase IV readiness which includes;
 - CO₂ pipeline FEED study
 - Storage Resource
 - Community Benefit Plans
- Complete all permitting
- Finalize and release the Environmental Assessment
- Refine and complete the commercial business model for the Wyoming CarbonSAFE Storage Hub



Questions?



Appendix

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Schedule/milestones/success criteria

Key milestones

Milestone Title & Description	Completion Date
Finalize initial environmental assessment	3/30/2021
Initiate drilling of UW PRB#2	9/30/2021
Update models with seismic and field data	1/1/2022
Initiate Class VI applications	11/1/2020
Submittal of Class VI permits	9/30/2022
Complete risk assessment	1/31/2023
Public Outreach meeting	9/1/2021
Identification of potential business partners	1/31/2023

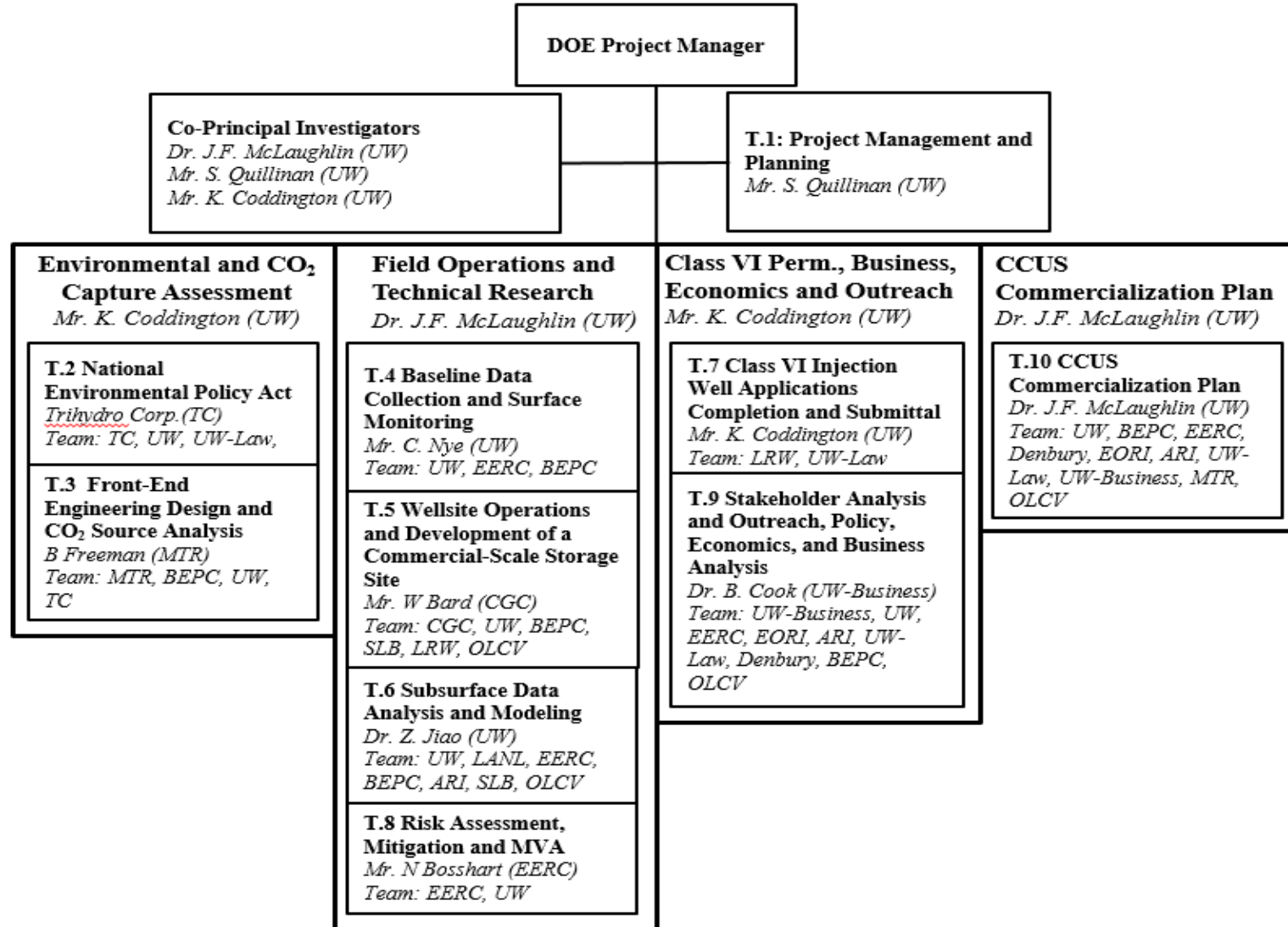
Success criteria

EIV identifies site(s) issues
CO ₂ capture study is not completed
Submitting and receiving applications to initiate drilling
Obtaining access agreements
Drilling UW PRB#2
Complete subsurface field testing and monitoring

Project risks and mitigation strategies

Perceived Risk	Mitigation/Response Strategy
Financial Risks:	
Drilling expenses	Rates are subject to the market price of oil. If rates increase, the co-PIs will look for ways to absorb costs in other areas of the project.
Cost/Schedule Risks:	
Project timeline	The Project timeline was developed based on the experienced gained from previous projects of this scale and will communicate regularly with the DOE program Manager.
Technical/Scope Risks:	
NEPA assessments	UW will select an environmental consultant with a proven record of accomplishment of EIVs.
Drilling and field operations	Challenges will be addressed through the team's prior experience with drilling operations and the selection of experienced contractors and commercial technologies.
Data collection	The team has extensive experience performing fieldwork in the PRB and has successfully collected the necessary data
Subsurface modeling	CEGR, EERC and ARI have extensive experience with the industry-standard software packages that will be used
Class VI well permitting	WYDEQ has received Class VI primacy and the Project team has collaborated closely with WYDEQ on permitting strategies
CO ₂ source commitment	As demonstrated by the CO ₂ source commitment letters, BEPC (source) and MTR (capture) can provide the CO ₂ for successful implementation of future phases.
Management, Planning and Oversight Risks:	
Project Management	Risks are negligible due to the team's collective experience in projects of this type.
ES&H Risks:	
Operations	All physical activities, including drilling, will be overseen in compliance with applicable laws.
External Factor Risks:	
Site access	The drilling site is on land owned by partner BEPC, which mitigates these concerns.
Pore space ownership	Risk will be addressed by WY law, which defines pore space ownership; minimization of project impacts; and project siting to focus impacts on land owned by team members. Risks are at medium due to the first-of-its-kind program.
Public acceptance	The Project team will continue to implement the outreach strategy deployed during Phases I & II.
Resource availability	Resource availability risks include access to a drilling site, equipment and skilled labor. These are negligible as BEPC will construct the drilling site and the PRB has a skilled workforce.

Organization Chart



Gantt Chart

	Year 1				Year 2				Year 3			
	Budget Period I								Budget Period II			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.0 Project Management and Planning												
1.1 Project Management Plan	M.1											
1.2 Data Management Plan												
1.3 Technology Maturation Plan												
2.0 National Environmental Policy Act												
2.1 Preparation and Submission for NEPA for CO2 Capture												
2.2 Preparation of EIV	M.2											
2.3 Preparation and Submission of NEPA for CO2 storage												
3.0 FEED and CO2 Capture Analysis												
3.1 Summary of the FEED CO2 capture												
3.2 Assessment of DE-FOA-0002058												
4.0 Baseline Data Collection Monitoring												
4.1 Establish microseismicity baselines												
4.2 Establish monitoring baselines				M.3								

5.0 Wellsite Operations and Development												
5.1 Permitting and approvals												
5.2 Site Preparation												
5.3 Drilling Operations												
5.4 Downhole sampling and logging												
5.5 Subsurface field testing and monitoring												
5.6 Site closure												
6.0 Subsurface Data Analysis and Modeling												
6.1 Subsurface data analysis												
6.2 Process and interpret seismic 3D survey												
6.3 Complete models of geological structure												
6.4 Update numerical injection simulations												
6.5 Geomechanical modeling												
6.6 Machine Learning												
6.7 NRAP risk assessment of legacy wellbores												
7.0 Class VI Injection Well Applications												
7.1 Permitting technical data and plans	M.6											
7.2 Other permit data and filing of applications											M.7	
7.3 Technical review of engineering standards												
8.0 Risk Assessment, Mitigation and MVA												
8.1 Risk Assessment and Mitigation												M.8
8.2 Finalize an MVA Plan												
9.0 Stakeholder Analysis and Outreach, Policy, Economics, and Business Analysis												
9.1 Stakeholder Analysis and Public Outreach												
9.2 Regulatory and policy assessment												
9.3 Finalize commercial business plan												
9.4 Implementation of the business plan												
9.5 Preparation of a staged build-out plan												
10 CCUS Commercialization Plan												



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