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Critical Challenges. Practical Solutions.

Energy & Environmental Research Center (EERC)

Improving Enhanced Oil Recovery Performance Through Data Analytics and Next-Generation Controllable Completions (FE0031790)

2024 NETL Resource Sustainability Project Review Meeting

Pittsburgh, PA

April 2, 2024

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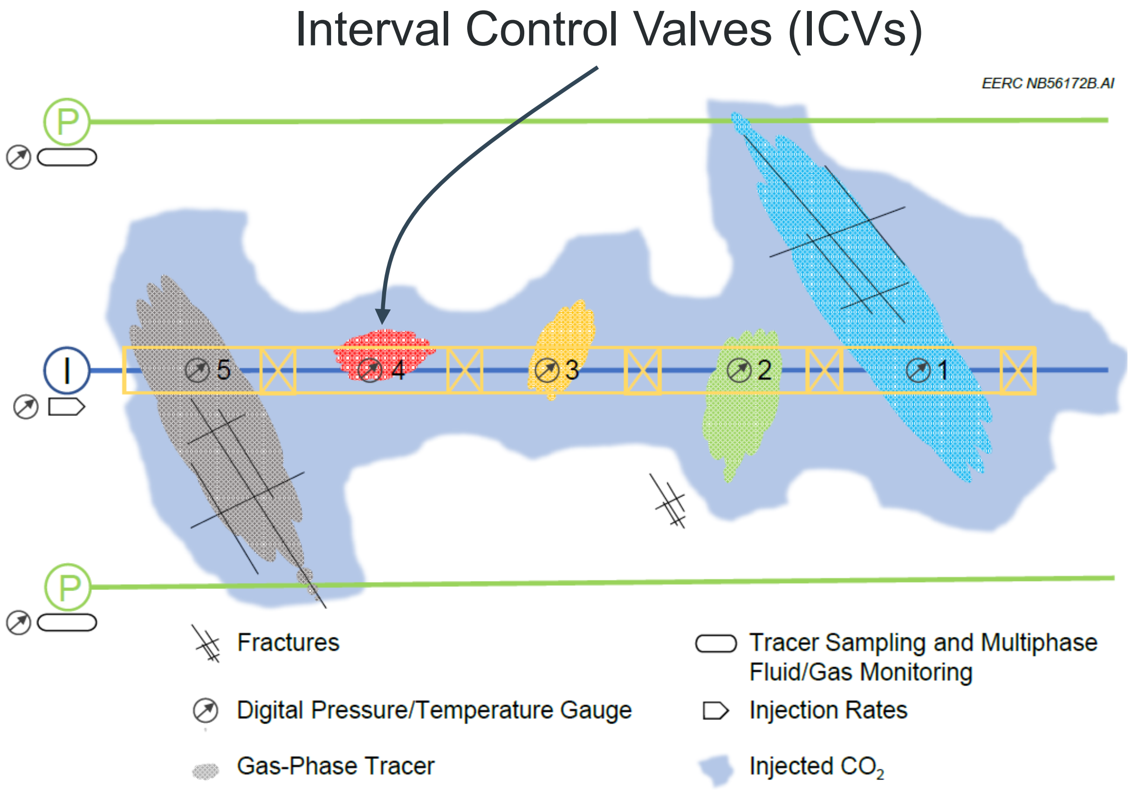
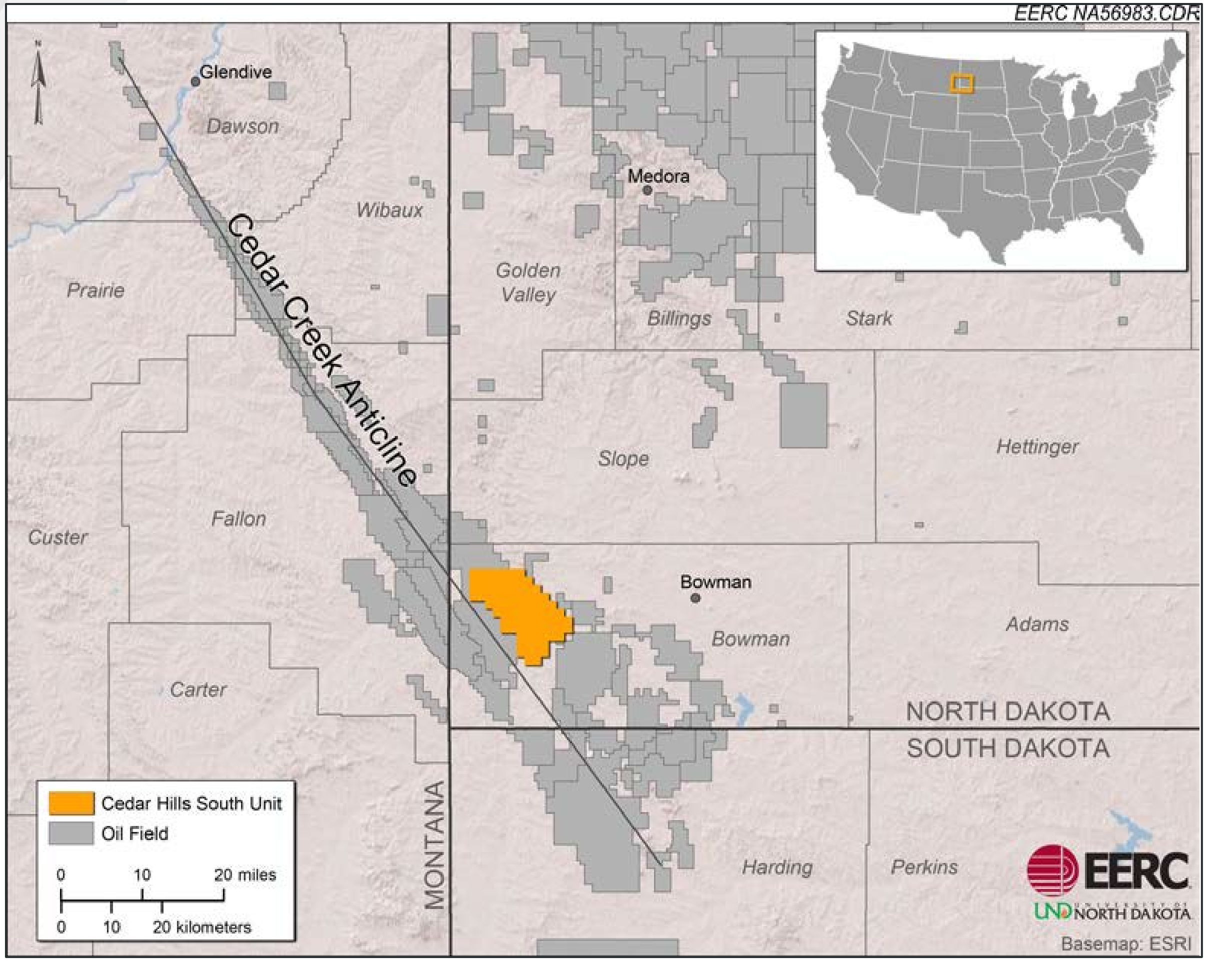
Presentation Outline

- Provide a high-level overview of this "controllable completions" project.
- Summarize the work done to date.
- Discuss the forthcoming fieldwork and installation of the controllable completion technology.



Red River Formation Cedar Creek Anticline

Project Location and Objectives

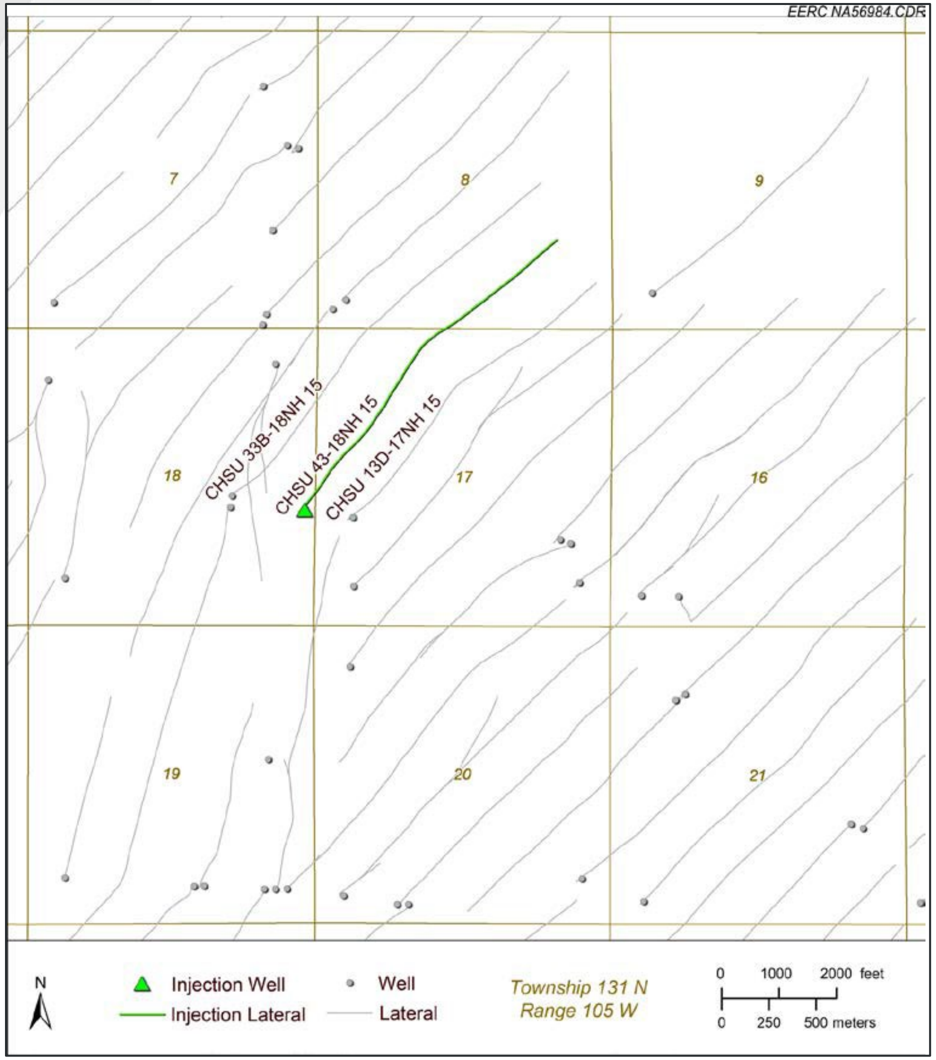


- Implement controllable completions through a rigorously monitored field test in the Cedar Hills South Unit (CHSU) Field, part of the Cedar Creek Anticline (CCA).
- Apply machine learning to evaluate the test performance and develop active control system.
- Assess various business cases to accelerate development and application of this system for commercial enhanced oil recovery (EOR).

Project Partners

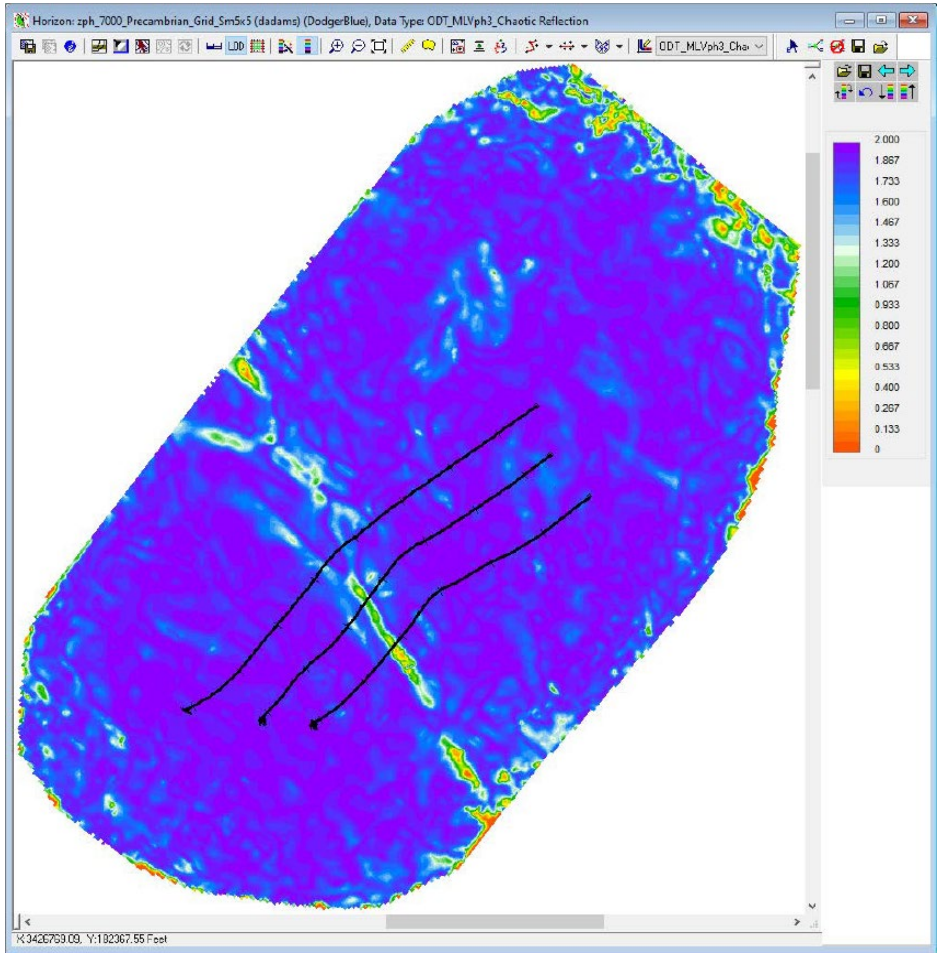
- **Lead Organization**
  - Energy & Environmental Research Center
- **Project Partners**
  - U.S. Department of Energy
  - North Dakota Industrial Commission Oil & Gas Research Program
  - Denbury
  - North Dakota Geological Survey
  - Slb
  - Computer Modelling Group Ltd.
  - Entech, Head Energy, and PetroQuip

Project Test Pattern



- Candidate injection well is CHSU-43-18NH-15 (API3301101001).
- To increase the chance of success in installing and operating the ICV system, we plan to abandon the existing lateral and drill a sidetrack.
- Additional fieldwork includes:
  - Logging the sidetrack.
  - Conducting a dummy (mock) run.
  - Installing the final ICV system.

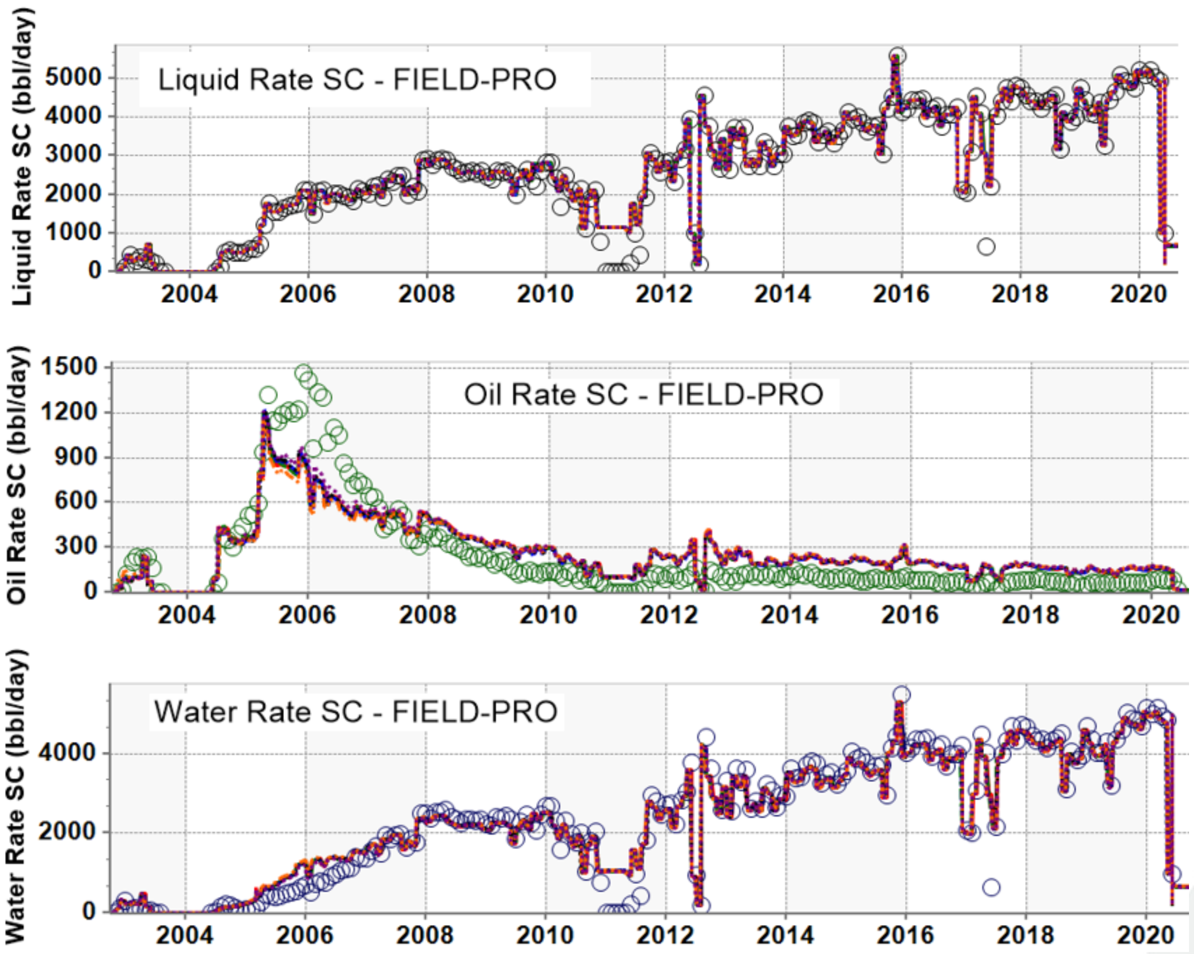
Baseline 3C3D Seismic of the Project Test Pattern



- A baseline three-component, three-dimensional (3C3D) seismic survey was acquired from the test pattern area on November 1–14, 2020.
- Processing included PP PSTM (pre-stack time migration) and PS (i.e., converted wave) processing.
- The baseline seismic will be used with the FMI log to inform the final ICV system design and evaluate the test performance.

Geomodeling and Reservoir Simulation

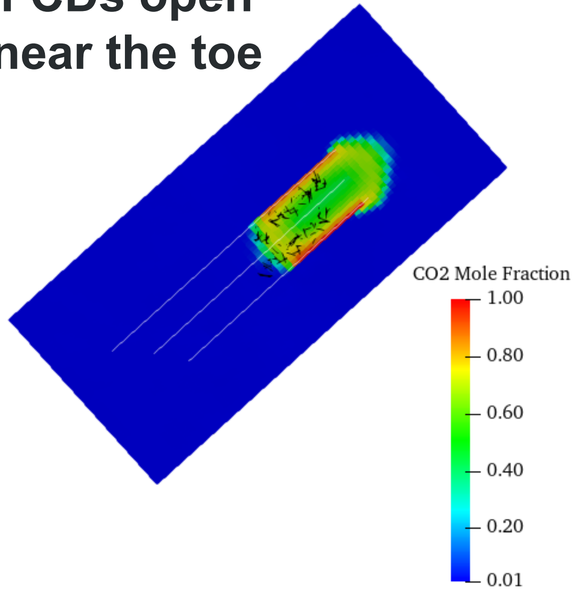
- Beginning with a baseline geomodel from Denbury, we developed an initial pattern-level STARS model to study flow behavior in the pilot test pattern.
- The model includes one water/CO_2 injector and two offset producers.
- The production and injection data of the three wells were processed and integrated into the simulation model to conduct the history-matching.



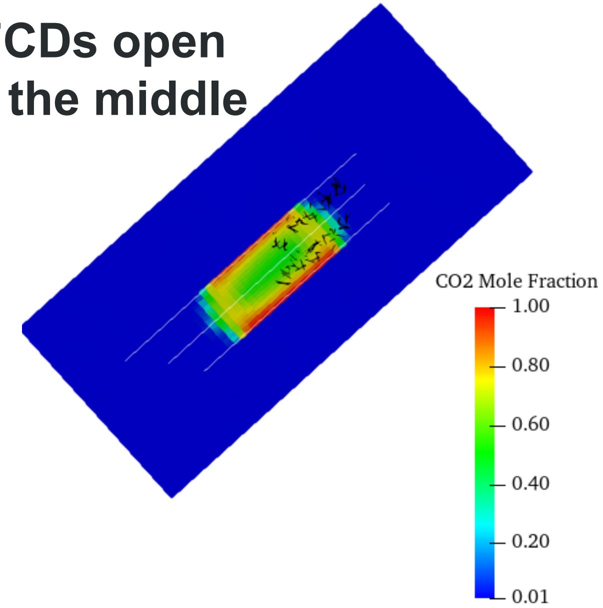
Geomodeling and Reservoir Simulation (cont.)

- The reservoir simulations use the Computer Modelling Group (CMG) module, FlexWell, within STARS to segment the injection well into zones using flow control devices (FCDs).
- The FCD zones will mirror the final ICV system design.
- An embedded discrete fracture model (EDFM) technique models reservoir natural fractures.

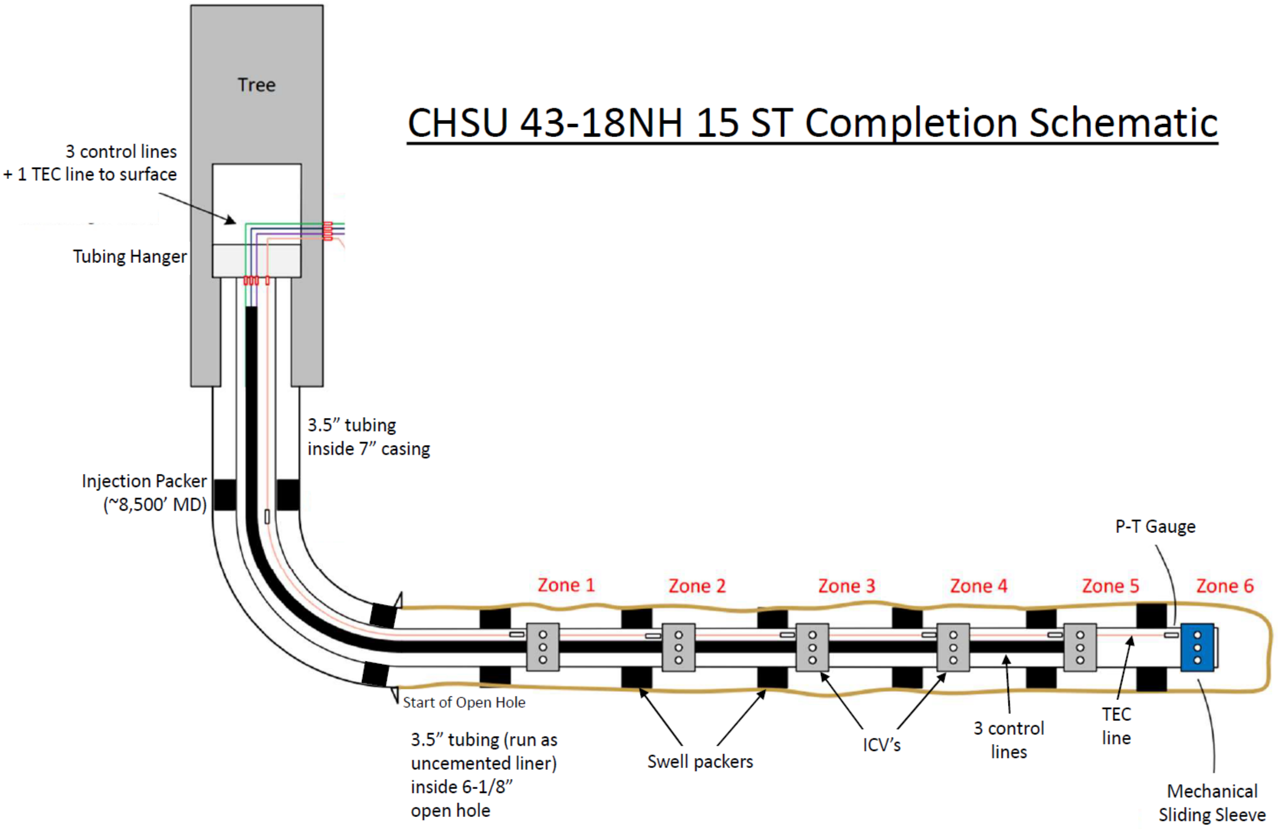
FCDs open near the toe



FCDs open in the middle

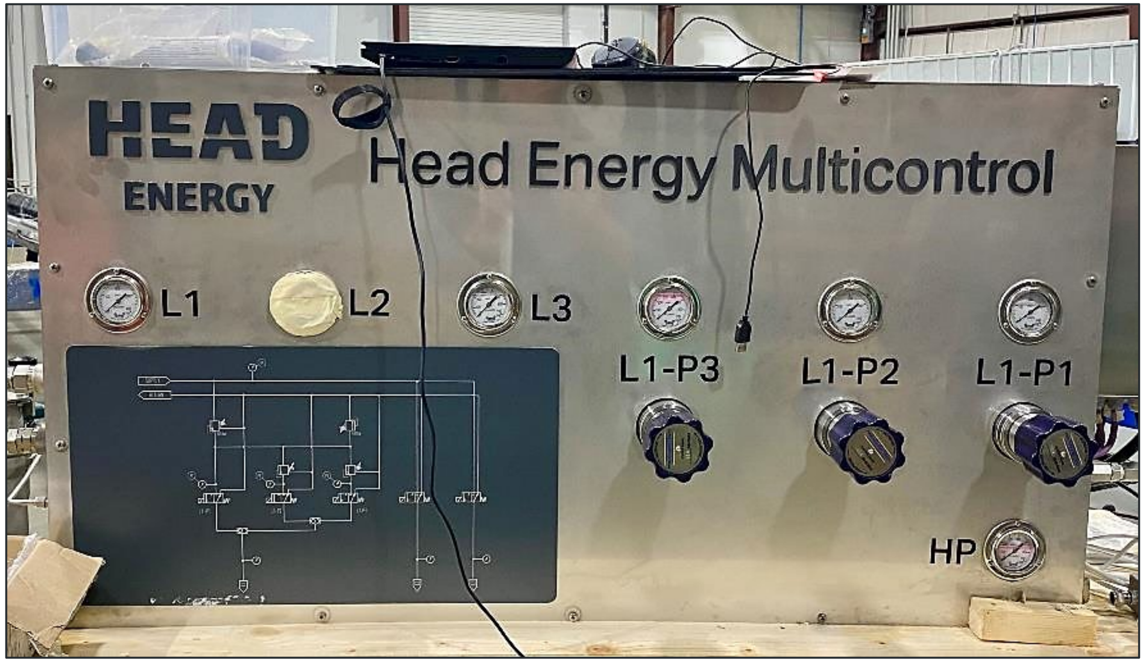


ICV System Schematic



- The lateral will be segmented into zones using swell packers.
- Each zone will have hydraulic valves that can be opened and closed through a mechanical system that links to a surface control.
- Each zone will continuously monitor pressure and temperature.
- The final design is pending the formation micro-imager (FMI) logging of the sidetrack.

ICV System Photos



Photos from the Complete Well on Paper (CWOP) walkthrough on November 16, 2023, at the PetroQuip facility in Houston, TX.

Project Task Structure

Budget Period 1
(10/1/19 – 9/30/24)

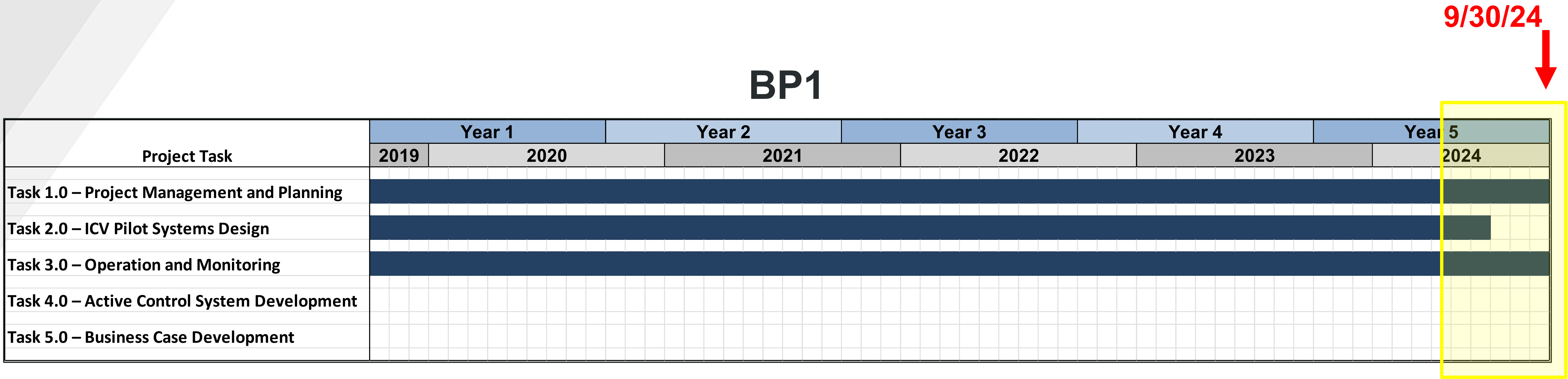
- **Task 1: Project management**
- **Task 2: ICV system design**
  - Selection of test pattern
  - Characterization
  - Baseline modeling
  - Pilot design
- **Task 3: Operation and monitoring**
  - Install and test the system

Budget Periods 2 & 3
(10/1/24 – 9/30/27)

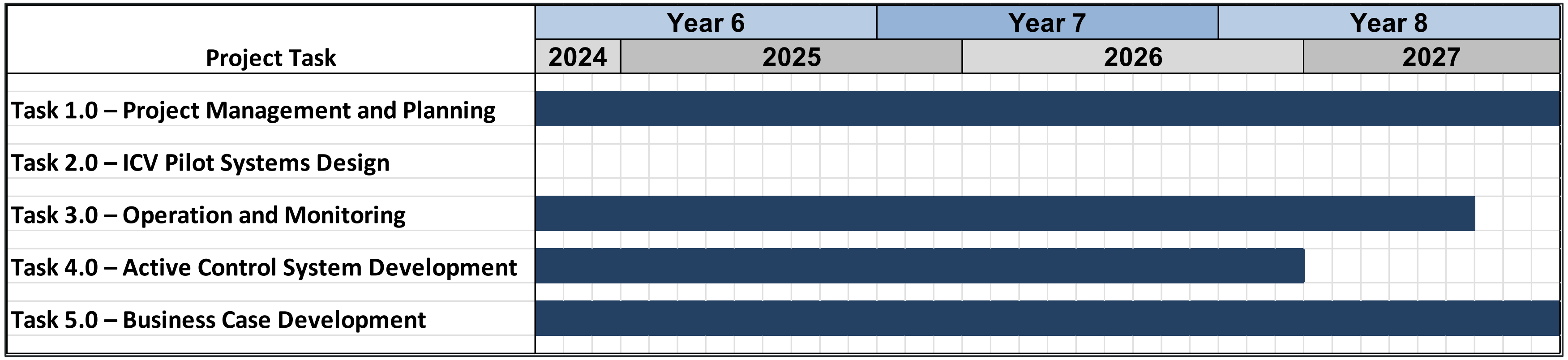
- **Task 3: Operation and monitoring**
  - System operation and monitoring
- **Task 4: Active control system**
  - Database and user interface
  - Active control system development
- **Task 5: Business cases**
  - Long-term performance simulation
  - Business case development

Project Timeline

BP1



BP2 & BP3



Summary

- We are conducting a pilot project to field-test an advanced machine-learning approach integrating controllable completions to enable active well control during CO_2 EOR.
- The CO_2 EOR pilot test will be conducted in the CHSU Field, part of the CCA in southwestern North Dakota.
- The remaining fieldwork includes abandoning the existing lateral, drilling a sidetrack, logging the sidetrack, conducting a dummy (mock) run, and installing the final ICV system. Long-term operational monitoring will continue through 2027.
- Our project partners remain committed to executing the project, and we look forward to completing the successful installation of the ICV system and moving into the next budget period.

ACKNOWLEDGMENT

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DISCLAIMER

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