Plains CO_2 Reduction (PCOR) Partnership Monthly Update
January 1–31, 2017

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota, South Dakota, Montana, Wyoming, Nebraska, and Saskatchewan well and production data.
  - Continued database preventive maintenance of Petra projects.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued the internal review of the draft value-added report.
  - Made revisions to the draft value-added report based on comments from the internal review.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Worked with Computer Modelling Group Ltd.'s (CMG's) CMOST (an assisted history-matching software) to determine how to use injection flow profile data obtained from spinner log surveys as a history-matching variable.

Task 2 – Public Outreach and Education (Daniel J. Daly)

Highlights

- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - PPB personnel traveled to Grand Forks, North Dakota, on January 4, 2017, to perform interviews with Ed Steadman and Roy Beard, EERC, for the D22 documentary.
  - Traveled to Fargo, North Dakota, on January 23, 2016, to meet with PPB personnel with respect to D22.
- Submitted a draft 1-hour documentary entitled "Coal Powered" for U.S. Department of Energy (DOE) review on January 31, 2017 (Deliverable [D] 22).
- Continued work on a draft of the value-added update of the Phase II Terrestrial Sequestration fact sheet.

Task 3 – Permitting and NEPA (National Environmental Policy Act) Compliance (Charles D. Gorecki)

Highlights

- Submitted D76 entitled "Regulatory Perspective Regarding the Geologic Storage of CO_2 in the PCOR Partnership Region" on January 31, 2017.
- Participated in the Webinar entitled "Environmental Regulations under the Trump Administration: What They Mean for Your Business" on January 10, 2017, which was rescheduled by the presenter from December 15, 2016.

Task 4 – Site Characterization and Modeling (Charles D. Gorecki)

Highlights

- Continued writing and revising text and creating figures for the PCOR Partnership Site Characterization Best Practices Manual (BPM) (D35), including text and graphics for Section 5, Section 6.1 (Phase 1 – Site Screening), and Section 6.2 (Phase 2 – Feasibility).

Task 5 – Well Drilling and Completion (John A. Hamling)

This task ended in Quarter 3 – Budget Period (BP) 4, Year 7 (June 2014).

Task 6 – Infrastructure Development (Melanie D. Jensen)

Highlights

- Discussed the topic of interest for the 2017 D85 update (Opportunities and Challenges Associated with CO_2 Compression and Transportation during CCUS Activities). The focus at this time is CO_2 impurities. The resulting document should illustrate the costs and benefits of various changes that can be made to compression and pipeline infrastructure to enable different types of CO_2 sources to consider carbon capture and storage. Developed an outline.

Task 7 – CO_2 Procurement (John A. Harju)

This task ended in Quarter 4 – BP4, Year 6 (September 2013).

Task 8 – Transportation and Injection Operations (Melanie D. Jensen)

This task ended in Quarter 4 – BP4, Year 8 (September 2015).

Task 9 – Operational Monitoring and Modeling (John A. Hamling and Larry J. Pekot)

Highlights

- Submitted a memo on January 26, 2017, regarding official updated numbers for metric tons of CO_2 purchased for injection and metric tons of CO_2 stored at Bell Creek. As of December 31, 2016, the most recent month of record, 3.583 million tonnes of total gas (composition of approximately 98% CO_2) has been purchased for injection into the Bell Creek Field, equating

to an estimated ***3.526 million tonnes of CO_2 stored***. At the end of BP4, 2.979 million tonnes of CO_2 had been stored.

- Submitted a paper entitled "The Value of 4-D Seismic Monitoring at Bell Creek – A Mature Oil Field Undergoing CO_2 Enhanced Oil Recovery" for consideration to be presented at the 79th European Association of Geoscientists and Engineers (EAGE) Conference & Exhibition 2017 to be held June 11–15, 2017, in Paris, France.
- **Bell Creek** injection-phase site activities included the following:
  - Continued reservoir pressure and distributed temperature monitoring of 05-06 OW (observation well) from the permanent downhole monitoring system using the casing-conveyed pressure–temperature gauges and fiber-optic distributed temperature system:
    - Near-continuous operation since April 2012.
  - Continued dynamic reservoir pressure and multiphase fluid flow simulation efforts. The modeling and simulation focus remains on Bell Creek Field Phase Areas 1–4. Accomplishments and activities include the following:
    - History matching of the simulation model is complete for Bell Creek Phase Areas 1–3.
    - Predictive simulation is complete for Bell Creek Phase Areas 1 and 2.
    - Long-term simulations of CO_2 migration are complete for Bell Creek Phase Areas 3–7.
    - Completed the history match of the primary depletion and water-flooding stages in Bell Creek Phase Area 4 based on the Version 2 geologic model.
    - Worked on testing the Phase 4 simulation model using the new Version 3 geologic model. Version 3 has an improved permeability distribution based on seismic attribute data and a revised depositional model. Reservoir layering and gridding are also improved, but more complex, in the Version 3 geologic model.
  - Worked on D104 (Analysis of Expanded Seismic Campaign). Drafted a preliminary table of contents.
  - Continued Bell Creek Field microseismic data processing focused on data collected May–June 2013 and June–July 2014, including the following:
    - Continued work on the model for microseismic event localization.
    - Worked on testing new microseismic model on passive data.
    - Worked on refining the microseismic velocity model after integrating Bell Creek Field horizons and well logs. This is one of the fundamental steps in processing and interpretation.
  - Completed the pulsed-neutron log (PNL) acquisition on 11 Bell Creek wells as part of the expanded PNL program. Logging occurred January 8–22, 2017. Logs acquired were focused on Phase Areas 1 and 3.
  - Continued laboratory preparations for a hysteresis study to inform Version 3 simulation model parameters. Discussed conditions to use in the study.
  - Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 6,328,406 metric tons through November 30, 2016. This value represents the total gas amount injected, which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 98% CO_2 (Table 1).
  - As of December 31, 2016, the most recent month of record, 3.583 million tonnes of total gas (composition of approximately 98% CO_2) has been purchased for injection into the Bell Creek Field, equating to an estimated 3.526 million tonnes of CO_2 stored (Table 2), with the difference comprising other trace gases in the purchase gas stream. A separate methodology from that used to calculate total gas injected was used to calculate a

Table 1. Bell Creek CO_2 Gas Injection Totals for November 2016 (cumulative totals May 2013 to November 2016)[1]

	November 2016 Injection
Total, Mscf	3,671,587
Total, tons[2]	210,009
Total, tonnes[3]	190,702
Cumulative Total, Mscf	121,840,799
Cumulative Total, tons[2,4]	6,969,101
Cumulative Total, tonnes[3,4]	6,328,406

Source: Montana Board of Oil and Gas (MBOG) database.
[1] Total gas injection quantities are ***NOT CORRECTED*** for gas composition and include the combined purchased and recycled gas streams.
[2] Calculated utilizing a conversion of 17.483 Mscf/ton.
[3] Calculated utilizing a conversion of 19.253 Mscf/tonnes.
[3] Cumulative totals are for the period from May 2013 to the month listed.

Table 2. Cumulative Total Gas Purchased and Estimated Associated CO_2 Storage for the Bell Creek Field[1]

	December 2016 Gas Totals
Monthly Total Gas Purchased, MMscf[2]	1400
Monthly Total Gas Purchased, million tons[2]	0.080
Monthly Total Gas Purchased, million tonnes[2]	0.073
Cumulative Total Gas Purchased, MMscf[2,3]	68,980
Cumulative Total Gas Purchased, million tons[2,3]	3.946
Cumulative Total Gas Purchased, million tonnes[2,3]	3.583
Cumulative Total CO_2 Stored, MMscf[3,4]	67,885
Cumulative Total CO_2 Stored, million tons[3,4]	3.883
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.526

[1] Conversion factors of 17.483 Mscf/ton and 19.253 Mscf/tonne were used to calculate equivalent purchase and storage quantities.
[2] Total gas purchased *NOT CORRECTED* for gas composition.
[3] Cumulative totals are for the period from May 2013 to the month listed.
[4] Total CO_2 stored *CORRECTED* for gas composition.

cumulative associated CO_2 storage volume estimate by correcting the gas purchase volume (approximately 98% CO_2) obtained from Denbury Onshore's (Denbury's) custody transfer meter with gas compositional data.

- Worked with Denbury personnel on the fifth round of oil sample collection from a select group of wells in the Bell Creek Field.
- Continued oil composition analyses of oil samples collected from the Bell Creek oil field.

A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.

Table 3. Oil and CO_2 Gas Stream Sampling and Analyses

Date Sampled	Purchase/ Recycle[1]	Production Stream by Development Phase, Well[1]									
		Phase 1				Phase 3			Phase 4		
		56-14R	32-02	05-06	04-04	28-02	21-10	21-14	34-09	34-07	34-03
Jan 2014		O	O	O							
Mar 2014		O	O								
May 2014	P	O	O	O							
Jun 2014	PR	O	O	O							
Jul 2014	PR	O	O	O							
Sep 2014	PR	OG	OG	O							
Oct 2014	PR	O	O								
Nov/Dec 2014		OG	OG	G							
Jan 2015			O	OG							
Mar 2015		G	G	G							
Apr 2015	PR										
Jun 2015		O	O	O							
Jul 2015	PR	G	G	G							
Sep 2015	PR										
Nov 2015		O		O							
Jan 2016	PR										
Apr/May 2016		O	O	O	O	O	O	O			
Jun/Jul 2016	PR	O		O	O	O	O	O			
Aug/Sep 2016		O	O		O	O	O	O	O		
Oct 2016				O							
Nov/Dec 2016[2]	PR	O	O	O	O	O	O	O	O	O	O

[1] P = purchase CO_2 gas stream, R = recycle CO_2 gas stream, O = produced oil stream, and G = produced CO_2 gas stream.
[2] Oil samples collected but not yet analyzed.

Task 10 – Site Closure (John A. Hamling)

Highlights

- Nothing to note at this time.

Task 11 – Postinjection Monitoring and Modeling (John A. Hamling and Larry J. Pekot)

Highlights

- Nothing to note at this time.

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Nothing to note at this time.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- David Nakles and Nicholas Azzolina have joined the EERC team. The CETER Group, as an entity, is no longer involved with the PCOR Partnership.
- Received approval for M36 entitled "Technical Advisory Board Meeting Scheduled" on January 3, 2017.
- Charlie Gorecki, Ed Steadman, and John Harju attended the IEA Greenhouse Gas R&D Programme Fiscal Year 2017 (FY17) Regional Carbon Sequestration Partnerships (RCSP) Expert Review held January 23–27, 2017, in Pittsburgh, Pennsylvania. Charlie Gorecki, the PCOR Partnership project manager, presented an update on PCOR Partnership activities, including how these activities are meeting the goals of the RCSP program. This was followed by a question-and-answer session and deliberation by the panel. Several staff members from the EERC participated via phone.
- The PCOR Partnership project manager attended a site visit to Southern Company in Birmingham, Alabama, hosted by Richard Esposito, Southeast Regional Carbon Sequestration Partnership, on January 5–6, 2017, to discuss potential areas of collaboration.
- Held a meeting to discuss the latest PCOR Partnership programmatic risk assessment. Developed a plan to finalize the results and incorporate lessons learned into future PCOR Partnership deliverables (e.g., risk assessment BPM).
- Hosted an Energy Roundtable on January 20, 2017. Key PCOR Partnership partners gave brief updates on energy topics and their primary focus.
- Continued planning for the 2017 PCOR Partnership Annual Membership Meeting, including potential meeting dates and hotels.
- Continued planning the 2017 Technical Advisory Board (TAB) meeting, including the following:
  - Determined final dates of the meeting: May 22–24, 2017.
  - Worked on selecting location and hotel.
- Completed deliverables and milestones in January:
  - December monthly update
  - Task 2: D22 – Coal Powered
  - Task 3: D76 – Regulatory Perspective Regarding the Geologic Storage of CO_2 in the PCOR Partnership Region

Task 14 – RCSP Water Working Group (WWG) Coordination (Ryan J. Klapperich)

Highlights

- Received approval for D106 entitled "Special Issue of IJGGC – Nexus of Water and Carbon Capture and Storage" on January 3, 2017.
- A researcher participated as a panelist for the "Science Challenges to Improve Industrial Water Use" at the DOE workshop: Basic Research Needs for the Energy–Water Nexus: New Approaches to Ensure Robust and Secure Energy and Water Systems on January 4–6, 2017, in Bethesda, Maryland. Over 150 participants and observers representing the national labs, academia, and industry were invited and tasked with providing an assessment of the basic science bottlenecks and gaps in the fundamental understanding of issues related to the energy–water nexus. Priority research directions were established for improving water use in

industrial applications, reducing water use in energy production, challenges to increase fit-for-purpose water availability, and crosscutting basic science in the energy–water nexus.
- Expanded the draft outline for D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS).

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project (Charles D. Gorecki)

This task ended in Quarter 2 – BP4, Year 7 (February 2014).

Task 16 – Characterization of the Basal Cambrian System (Wesley D. Peck)

This task ended in Quarter 2 – BP4, Year 7 (March 2014).

Travel/Meetings

- January 3–6, 2017: traveled to Bethesda, Maryland, to participate as a panelist at the Basic Research Needs for Energy–Nexus Conference.
- January 4–8, 2017: traveled to Birmingham, Alabama, to visit Southern Company and tour project sites.
- January 4–13, 2017: traveled to Gillette, Wyoming, to collect PNLs at the Bell Creek site.
- January 10–17, 2017: traveled to Gillette, Wyoming, for Bell Creek project work.
- January 16–20, 2017: off-site staff traveled to Grand Forks, North Dakota, for project work and meetings.
- January 23, 2017: traveled to Fargo, North Dakota, to work on the "Coal Powered" documentary with PPB.
- January 23–25, 2017: traveled to Pittsburgh, Pennsylvania, to attend and present at the FY17 Regional Sequestration Partnership Expert Review meeting.

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