Plains CO_2 Reduction (PCOR) Partnership Monthly Update
June 1–30, 2017

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Shipped copies of the "PCOR Partnership Atlas 5th Edition" (Deliverable [D] 81) to PCOR Partnership contacts.
- Continued work on the yearly review of the CO_2 sources data set for D1 – Review of Source Attributes (update).
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota, South Dakota, Montana, Nebraska, and Manitoba well information.
  - Continued database preventive maintenance of Petra projects.
- Modified maps for a value-added report on the geologic characterization and CO_2 storage potential of the state of Nebraska following internal review.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Made revisions to the draft value-added report based on internal review.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Downloaded and processed injection and pressure data through June 5, 2017.
  - Participated in a Science and Engineering Research Committee (SERC) conference call on June 28, 2017.
  - Updated the history match of the pressure response and well log data.
  - Set up an updated base-case forecast.

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

Highlights

- Prairie Public Broadcasting (PPB) aired the broadcast premiere of *The Bell Creek Story: CO_2 in Action* on June 19 at 7 p.m.
- Submitted Milestone (M) 47 entitled "Bell Creek Test Site – 30-minute Documentary Broadcast" on June 29, 2017.
- Received approval for D17 entitled "General Audience CO_2 Sequestration Outreach PowerPoint Presentation" on June 14, 2017.

- In preparation for the PPB broadcast premiere of the D21 documentary *The Bell Creek Story: CO_2 in Action* (M47) on June 19 at 7 p.m., the following occurred:
  - U.S. Department of Energy (DOE) review and approval of the following proposed changes to the PCOR Partnership public Web site were requested on June 15, 2017, which then occurred at the time of the broadcast premiere:
    - The Bell Creek Story: CO_2 in Action – new page
    - Documentaries page – updated to include the new documentaries
    - Home page – changed the Featured Documentary at the bottom of the page to *The Bell Creek Story*
    - Request Information form – Added *The Bell Creek Story* to the order form
  - Coordinated promotion of the documentary premiere with PPB.
  - Sent video clip production instruction to PPB to begin making video clips from *The Bell Creek Story: CO_2 in Action*.
  - Shipped copies of *The Bell Creek Story: CO_2 in Action* DVD to PCOR Partnership contacts.
- The PCOR Partnership task leader attended the Lignite Energy Council (LEC) Teacher Seminar held June 13, 2017, in Bismarck, North Dakota, and presented "Energy and CO_2 Management: Carbon Capture and Storage." Prior to the event, 110 teacher packets were shipped to the conference venue.
- Continued writing text and compiling images for the draft updated Phase II Zama fact sheet.
- Continued work on updates and revisions to the PCOR Partnership public Web site, including the following:
  - Continued work on Web pages to accompany the PPB broadcast premiere of the D21 documentary, including preparing draft pages for National Energy Technology Laboratory (NETL) review.
  - Continued content updates and preparation for Web site format on the following pages:
    - Aquistore Project
    - Boundary Dam Project
    - CO_2, Climate, and Sequestration
    - Weyburn–Midale
    - Greenhouse Effect
    - Fort Nelson
  - Replaced the 2016 PCOR Partnership Annual Meeting and Workshop image and hyperlink on the home page with the 2017 PCOR Partnership Annual Meeting and Workshop image and hyperlink. This went live June 9, 2017.
  - Programmed and uploaded technical reports.
- Worked with all 80 PCOR Partnership videos on the public Web site. The videos now play in all Web browsers.

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

Highlights

- Nothing to note at this time.

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

This task ended in Quarter 1 – Budget Period (BP) 5, Year 10 (March 2017).

Highlights

- Received approval for D35 entitled "Best Practices Manual (BPM) for Site Characterization" on June 14, 2017.

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

This task ended in Quarter 3 – BP4, Year 7 (June 2014).

Task 6 – Infrastructure Development (Melanie D. Jensen)

Highlights

- Accepted an invitation to participate as an instructor/mentor at the IEAGHG (International Energy Agency Greenhouse Gas R&D Programme) Summer School to be held July 17–23, 2017, in Regina, Saskatchewan, Canada. Submitted a presentation entitled "CO_2 Transport" to IEAGHG. Prepared notes to accompany the updated PowerPoint presentation for another PCOR Partnership representative who will be presenting the topic.
- Received approval for D85 entitled "Opportunities and Challenges Associated with CO_2 Compression and Transport During CCS (Carbon Capture and Storage) Activities" on June 29, 2017.

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 and received approval for M64 entitled "Initial Analysis of Expanded Seismic Campaign Data Completed" on June 27, 2017.
- Submitted the executive summary of D104 entitled "Analysis of Expanded Seismic Campaign" on June 30, 2017. The report is being reviewed by Denbury. If deemed not confidential, the client-approved version will be submitted upon completion of Denbury review.
- The PCOR Partnership Project Manager attended the 79th European Association of Geoscientists & Engineers (EAGE) Conference & Exhibition 2017 held June 12–15, 2017, in Paris, France, and presented "The Value of 4-D Seismic Monitoring at Bell Creek – A Mature Oil Field Undergoing CO_2 Enhanced Oil Recovery."
- The PCOR Partnership task leader attended the IEAGHG Monitoring and Network Meeting held June 13–15, 2017, in Traverse City, Michigan, and presented "Integrating Monitoring

Data: Understanding Reservoir Behavior and CO_2 Movement at the Bell Creek Commercial CO_2 EOR (Enhanced Oil Recovery) Project." The task leader also participated in the Near-Surface/Surface Baseline Monitoring – Commonalities/Site-Specific Subtleties and Leakage Monitoring panel session presenting information on the Bell Creek project.

- Attended the American Rock Mechanics Association (ARMA) Symposium and Hydraulic Fracturing Workshop held June 25–28, 2017, in San Francisco, California.
- Accepted an invitation to participate as an instructor/mentor at the 2017 IEAGHG Summer School to be held July 17–23, 2017, in Regina, Saskatchewan, Canada. Submitted a presentation entitled "Wellbore Integrity" to IEAGHG.
- Continued work on the BPM – Monitoring for CO_2 Storage and CO_2 EOR (D51), including the following:
  - Revised the outline.
  - Revised text in the monitoring, verification, and accounting (MVA) overview section.
  - Developed recommended best practices, lessons learned, and case studies and placed in the appropriate sections.
  - Worked on the text in several sections.
- Worked on outline and draft content for D66 Simulation Report Update 6, including information regarding the construction of the Version 3 (V3) static geologic model.
- Based on mutual agreement with the DOE project manager, the PCOR Partnership plans to submit an update to D69 (Best Practices for Modeling and Simulation of CO2 Storage), which was submitted May 31, 2017, that incorporates additional reviewer perspectives and findings. Met to discuss the path forward for revisions. Worked on revisions to lessons learned, case studies, and text.
- **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.
  - Received approval from Denbury to acquire several check shots with a trailer-mounted weight-drop source (source purchased for use on a separate DOE project) to aid in calibration and interpretation of data collected using the permanent borehole array in Well 04-03 OW. Anticipate a field trip for borehole array restart and check shot acquisition in mid-July 2017.
  - Continued dynamic reservoir pressure and multiphase fluid flow simulation efforts. The modeling and simulation focus remains on Bell Creek Oil Field Phase Areas 1–4. Accomplishments and activities include the following:
    - History matching of the simulation model is complete for Phase Areas 1–3. Predictive simulation is complete for Phase Areas 1 and 2. Long-term simulations of CO_2 migration are complete for Phase Areas 3–7.
    - History matching of the simulation model is complete for the waterflooding and CO_2-flooding stages for Phase Area 4 using the simulation model based on the V3 geologic model.
    - Prepared restart files for CCI (continuous CO_2 injection) and WAG (water alternating gas) operations in the Phase Areas 1–2 combined model. Worked on a long-term CO_2 migration simulation using the combined model. The purpose of the simulation is to predict the distribution of the CO_2 plume following the completion of EOR operations.
  - Completed seismic well tie for 23 pulsed-neutron log wells in the Bell Creek Petrel model.

- Worked on incorporating rock mechanics well logs into a geomechanical inversion project.
- Worked with processed InSAR (interferometric synthetic aperture radar) data spanning September 2015 to May 2016, including the following:
  - Performed evaluations using spatial statistical tools. Compared results to seismic data and well production/injection data.
  - Delineated dewatering structures in the Belle Fourche Formation (above the Bell Creek Sands reservoir) using seismic volume attributes to compare with InSAR ground deformation.
  - Worked on a Phase 4 CO_2-flooding simulation to obtain pressure data for individual wells, which will be used in InSAR calculations.
- Continued with interpretation of the results from a hysteresis study to inform simulation model parameters, including the following:
  - Worked on finalizing hysteresis curves from the permeability and hysteresis tests in a hysteresis study and plotted with respect to CO_2.
  - Worked on relative permeability hysteresis curve modeling based on oil and gas relative permeability curves measured using CO_2–oil drainage–imbibition cycles performed previously.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 7,327,314 tonnes through April 30, 2017. 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 March 31, 2017, the most recent month of record, 3.787 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 3.728 million tonnes of CO_2 stored (Table 2), with the difference comprising other trace gases in the purchase gas stream. A separate method from that used to calculate total gas injected was used to calculate a cumulative associated CO_2 storage volume estimate by correcting the gas purchase volume (approximately 98% CO_2) obtained from Denbury's custody transfer meter with gas compositional data.
- Worked with Denbury to sample purchase/recycle samples in the Bell Creek oilfield.
- Updated Denbury on field crude oil sampling, molecular weight analyses, and data reduction/presentation.
- A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.

Table 1. Bell Creek CO_2 Gas Injection Totals for April 2017 (cumulative totals May 2013 to April 2017)[1]

	April 2017 Injection
Total, Mscf	4,011,941
Total, tons[2]	229,477
Total, tonnes[3]	208,380
Cumulative Total, Mscf[4]	136,976,749
Cumulative Total, tons[2,4]	7,834,854
Cumulative Total, tonnes[3,4]	7,114,567

Source: Montana Board of Oil and Gas 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/tonne.

[4] 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]

	March 2017 Gas Totals
Monthly Total Gas Purchased, MMscf [2]	1439
Monthly Total Gas Purchased, million tons[2]	0.082
Monthly Total Gas Purchased, million tonnes[2]	0.075
Cumulative Total Gas Purchased, MMscf [2,3]	72,903
Cumulative Total Gas Purchased, million tons[2,3]	4.170
Cumulative Total Gas Purchased, million tonnes[2,3]	3.787
Cumulative Total CO_2 Stored, MMscf [3,4]	71,780
Cumulative Total CO_2 Stored, million tons[3,4]	4.106
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.728

[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.

Table 3. Oil and CO_2 Gas Stream Sampling and Analyses

		Production Stream by Development Phase, Well[1]									
		Phase 1				Phase 3			Phase 4		
Date Sampled	Purchase/ Recycle[1]	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
Feb 2017[2]		O	O		O	O	O	O	O	O	O
May 2017[2]		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

- Drafted an outline for D73 (Monitoring and Modeling Fate of Stored CO_2).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Worked on updating sections in the BP5 Program Year 10 annual report based on deliverables and milestones submitted and the quarterly reports through March 2017.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Attended the 2nd International Workshop on Offshore Geologic CO_2 Storage held June 19–20, 2017, in Beaumont, Texas.
- Presented a poster entitled "Reducing Greenhouse Gas Emissions – Energy with a Smaller Carbon Footprint" at the Bureau of Economic Geology (BEG) Open House held June 21, 2017, in Beaumont, Texas.
- Completed the review of text from the Global Carbon Capture and Storage Institute (GCCSI) Web site regarding Bell Creek as requested by DOE. Updated the information using publically accessible information. Received input from a Denbury representative. Submitted the revised text to DOE on June 22, 2017.
- Submitted the quarterly international activity update on June 21, 2017.
- Developed an outline for the programmatic risk management BPM (D103). Began drafting text.
- Continued to work on a planned special issue of the *International Journal of Greenhouse Gas Control*.
- Continued planning for the PCOR Partnership annual membership meeting and workshop, including:
  - Worked with hotel on plans and the guest room reservation link.
  - Updated the venue page on the meeting Web site with the room block reservation information and link.
  - Sent an e-mail blast on June 28, 2017, to announce that meeting registration is open and the hotel room block is available.
  - Continued development of the draft agenda.
- Held a task leader meeting June 26, 2017. Topics discussed included recommendations from discussions at the 2017 annual technical advisory board meeting, deliverables, planning for the 2017 PCOR Partnership annual meeting, and task updates.
- Completed deliverables and milestones in June:
  - May monthly update
  - Task 2: M47 – Bell Creek Test Site – 30-minute Documentary Broadcast

- Task 9: M64 – Initial Analysis of Expanded Seismic Campaign Data Completed
- Task 9: D104 – Analysis of Expanded Seismic Campaign
- Task 14: M23 – Monthly WWG Conference Call Held

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

Highlights

- Revised text for D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS). Distributed the draft D107 to the WWG on June 26, 2017, in advance of the quarterly conference call.
- Distributed the notes from the March 30, 2017, conference call.
- Held the quarterly conference call for June 28, 2017. Topics included review of the draft outline and draft sections of D107, the draft agenda for the WWG annual meeting tentatively scheduled for August 2, 2017, and partnership updates.
- Worked on an agenda, potential guest speakers, and planning details for the WWG annual meeting.

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

- June 5–9, 2017: remote staff traveled to the Energy & Environmental Research Center (EERC) for project meetings.
- June 9–16, 2017: traveled to Paris, France, to present at the 79th EAGE Conference & Expo.
- June 12–13, 2017: traveled to Bismarck, North Dakota, to present at the LEC Teacher Seminar.
- June 12–16, 2017: traveled to Traverse City, Michigan, to attend the IEAGHG 11th Annual Network Meeting.
- June 18–22, 2017: traveled to Beaumont, Texas, to attend the 2nd International Workshop on Offshore Geologic CO_2 Storage.
- June 21, 2017: a staff member already in Beaumont, Texas, presented at the Lamar University Center for Innovation and Commercialization.
- June 24–28, 2017: traveled to San Francisco, California, to attend the ARMA Symposium and Hydraulic Fracturing Workshop.

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