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

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Began the yearly review of the CO_2 sources data set for Deliverable (D) 1 – Review of Source Attributes (update).
- Made changes to the PCOR Partnership members-only Decision Support System (DSS), which have not gone live, including the following:
  - On the Home page, replaced the atlas thumbnail with the PCOR Partnership Atlas 5th Edition image and updated the links to the PCOR Partnership Atlas 5th Edition.
  - On the Atlas page, replaced the banner with the Atlas 5 image, updated the title of the atlas, updated the downloadable PDF with the new version, and replaced the individual chapter PDFs.
  - On the Demonstration Projects page, replaced the Fort Nelson fact sheet with the most recent version.
  - On the Products Database page, updated the contact name to Janelle Ensrud.
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota and Manitoba well and production data.
  - Updated North Dakota injection data.
  - Updated Montana, South Dakota, and Wyoming well information.
  - Continued database preventive maintenance of Petra projects.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued internal review of the draft value-added report.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Continued to download and process injection and pressure data as available.
  - Participated in Science and Engineering Research Committee (SERC) conference calls on May 17 and May 31, 2017.
  - A new contracting agreement regarding data sharing and an Energy & Environmental Research Center (EERC)–Petroleum Technology Research Centre (PTRC) relationship with respect to modeling was signed and is effective as of May 30, 2017.

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

Highlights

- Submitted a value-added fact sheet update entitled "Terrestrial Carbon Sequestration Validation Test" on May 10, 2017, and received approval on May 11, 2017.
- Submitted D17 entitled "General Audience CO_2 Sequestration Outreach PowerPoint Presentation" on May 31, 2017, for review.
- Received approval for the value-added "Household Energy and Carbon Web Pages Report" for the January 1 – March 31, 2017, quarter on May 11, 2017.
- At the direction of Traci Rodesta, U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL), submitted a request to Darin Damiani and John Litynski, DOE Headquarters, to review and comment on the draft Documentary D22 entitled "Coal Powered" on May 18, 2017.
- Continued work related to Documentary D21 (*The Bell Creek Story – CO_2 in Action*), including the following:
  - Approved the DVD artwork proofs from the printer, RelyMedia. Received an order of 1000 DVDs on May 12, 2017.
  - Provided DVDs for distribution at the annual PCOR Partnership Technical Advisory Board (TAB) meeting held May 23–24, 2017.
  - Continued work on Web page components.
  - Reviewed and approved the Prairie Public Broadcasting (PPB) promotional spot for the documentary premiere scheduled for June 19, 2017.
  - Reviewed potential video clip content.
- Completed content changes for the presentation for the Lignite Energy Council (LEC) Teacher Seminar to be held in June 2017. Prepared lecture notes and student worksheet documents. Sent the presentation to LEC on May 27, 2017.
- Participated in the monthly Outreach Working Group conference call on May 18, 2017. The topics were a review of the CarbonSAFE (Carbon Storage Assurance and Facility Enterprise) activities and the update of the DOE Outreach Best Practices Manual (BPM).
- Continued revising text in 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 updates to the Technical Posters page.
  - Continued to work on content for a CO_2 storage feasibility study page related to the Red Trail Energy, LLC, ethanol facility.
  - Continued work on Web pages to accompany the PPB broadcast premiere of the D21 documentary, including updates to the Home page, Documentaries page, and Request Form.
  - Worked on preparations to add technical reports.
  - Prepared text to update the Fort Nelson and Weyburn–Midale project pages.

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

Highlights

- Attended the Interstate Oil and Gas Compact Commission (IOGCC) Annual Business Meeting, which was held May 7–9, 2017, in Oklahoma City, Oklahoma. A Task 3

representative represented North Dakota as the Vice Chairman of the Environment and Safety Committee.

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

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

- Submitted D85 entitled "Opportunities and Challenges Associated with CO_2 Compression and Transport During CCS Activities" on May 31, 2017, for review.

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 May 10, 2017, regarding official updated volumes of metric tons of CO_2 purchased for injection and metric tons of CO_2 stored at Bell Creek. 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***. At the end of BP4, 2.979 million tonnes of CO_2 had been stored.
- Submitted D69 entitled "Best Practices for Modeling and Simulation of CO_2 Storage" on May 31, 2017.
- Worked on a presentation entitled "The Value of 4-D Seismic Monitoring at Bell Creek – A Mature Oil Field Undergoing CO_2 Enhanced Oil Recovery" in preparation for the 79th European Association of Geoscientists & Engineers (EAGE) Conference & Exhibition 2017 to be held June 12–15, 2017, in Paris, France.
- Worked on a presentation entitled "Integrating Monitoring Data: Understanding Reservoir Behavior and CO_2 Movement at the Bell Creek Commercial CO_2 EOR (Enhanced Oil Recovery) Project" in preparation for the IEAGHG (International Energy Agency Greenhouse Gas R&D Programme) Monitoring Network Meeting to be held June 13–15, 2017, in Traverse City, Michigan.
- Continued work on the PCOR Partnership BPM – Monitoring for CO_2 Storage and CO_2 EOR (D51), including revising the draft outline, reviewing reference materials for discussion on

approach, drafting text for the monitoring, verification, and accounting (MVA) overview section, and determining case studies and best practices that will be included in the deliverable.

- Began preparing D66 Simulation Report Update 6.
- **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.
    - History matching of the simulation model is complete for the waterflooding and CO_2-flooding stages for Bell Creek Phase Area 4 using the Version 3 simulation model.
    - Worked on pressure and CO_2 plume distribution in the Bell Creek Phase 4 area. Generated rescue models, which are used to create images for evaluating the effects of CO_2 injection in the Phase 4 area.
  - Studied the relationship between time-lapse sigma log change and CO_2 volume changes from the interpreted pulsed-neutron logging (PNL) results of a Bell Creek Oil Field well.
  - Worked with Denbury Onshore (Denbury) to permit and acquire test shots to calibrate the passive seismic array for Well 04-03 OW. Anticipate test shot acquisition will be late June/July 2017.
  - Continued work on D104 (Analysis of Expanded Seismic Campaign), including the following:
    - Drafted all sections of the report.
    - Generated images and maps.
    - Started initial internal review.
    - Worked on modifications.
  - Continued 4-D seismic data analysis and interpretation to fine-tune figures for the D104 report.
  - Worked on comparing 4-D seismic response with PNL-measured CO_2 saturations for relevant Bell Creek wells.
  - Obtained Schlumberger's Techlog project containing interpretations completed for the wells logged in the January 2017 PNL campaign.
  - Worked with InSAR (interferometric synthetic aperture radar) data, including the following:
    - Worked with InSAR data for use in determining whether surface deformation has occurred as a result of production and/or injection activities.
    - Worked on voidage replacement ratio (VRR) analysis for well patterns in the Phase 4 area, which were selected based on InSAR response. VRR is a measure of the replacement of fluids produced from the reservoir by fluids injected within the reservoir, usually in the form of a pattern analysis (i.e., 5-spot pattern analysis).
    - Worked on the comparison of simulated CO_2 plumes and differential pressures to areas of InSAR-measured surface ascendance.

- Compared the fracture network in the Phase 4 area (generated by ant tracking seismic attributes) with InSAR response.
- Generated cross-sections in the Phase 4 area to compare well log response and petrophysical properties of the reservoir with InSAR response.
- Worked on results comparison between InSAR, seismic response, and production/injection behavior.

- Final InSAR monitoring results are expected in July 2017 from TRE Canada.
- Continued with a hysteresis study to inform Version 3 simulation model parameters, including the following:
  - Completed laboratory tests on the third and fourth study samples. Determined CO_2 permeability, brine permeability, oil permeability, and hysteresis.
  - Worked on data processing and interpretation in order to provide data for the simulation model.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 7,114,567 tonnes through March 31, 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).

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

	March 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.

- 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 methodology 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.

- Completed the sixth round of oil sample collection, with Denbury personnel, from a select group of wells in the Bell Creek Field. Analysis of the samples is on hold until field observations show CO_2 breakthrough in a newly CO_2-flooded area.

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.

- Continued work on data processing of oil composition and "miscible" phase analyses from previous sample sets.

- 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
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)

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

Highlights

- Began reviewing relevant materials and drafting an outline for D73 (Monitoring and Modeling Fate of Stored CO_2).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Nothing to note at this time.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Attended the Carbon Sequestration Leadership Forum (CSLF) Mid-Year Meeting, held April 30 – May 3, 2017, in Abu Dhabi, United Arab Emirates (UAE).
- Attended GeoConvention 2017 held May 15–19, 2017, in Calgary, Alberta, Canada, and presented "Demonstration of Secure CO_2 Geological Storage in the PCOR Partnership Region."
- Hosted the 2017 TAB meeting May 23–24, 2017, in San Francisco, California.
  - Discussed several topics, including updates on Bell Creek and Aquistore projects, PCOR Partnership BPM development, and other ongoing carbon capture and storage (CCS) projects in the PCOR Partnership region.
  - TAB members in attendance included Stefan Bachu, Stacey Dahl, Jim Erdle, Bill Jackson, Ray Hattenbach, Mike Jones, and Steve Melzer. Attending from the EERC were Scott Ayash, Charlie Gorecki, John Harju, Dave Nakles, Ed Steadman, and Neil Wildgust.
- Attended the 2017 Stanford Center for Carbon Storage (SCCS) Affiliates Meeting & Workshop at Stanford University held May 26, 2017, in Metro Park, California, and presented "The Plains CO_2 Reduction Partnership: CO_2 Injection Update and Results of Adaptive Management Approach."
- Completed revisions to D102/Milestone (M) 59 entitled "Best Practice for the Commercial Deployment of Carbon Dioxide Geologic Storage: Adaptive Management Approach" based on the concurrent review by the PCOR Partnership TAB members. Submitted the revised version on May 23, 2017, for additional DOE review and received approval on May 25, 2017.
- Worked on an outline for the programmatic risk management BPM (D103).
- Continued to work on a planned special issue of the *International Journal of Greenhouse Gas Control* focused on Bell Creek activities, including compiling a list of potential articles and working on a management plan.
- Continued planning for the PCOR Partnership annual membership meeting and workshop, including:
  - Signed a contract with a hotel in Plano, Texas.
  - Sent a Save the Date e-mail blast on May 16, 2017, to announce the meeting. The 2017 PCOR Partnership Annual Membership Meeting and Workshop will be held October 24–26, 2017, at the Renaissance Dallas at Plano Legacy West Hotel in Plano, Texas.
  - Sent the Save the Date postcards on May 19, 2017.
  - Held a planning meeting to discuss workshop ideas, potential speakers, attendee gift ideas, potential Pioneer Award recipients, and hotel developments.
  - The 2017 PCOR Partnership annual membership meeting Web site went live June 2, 2017, at www.undeerc.org/PCOR17.
  - Worked on the draft agenda.
- Held a task leader meeting May 2, 2017. Topics discussed included discussion of the PCOR Partnership BPMs, planning for the 2017 TAB and PCOR Partnership annual meetings, Bell Creek project updates, upcoming conferences, and task leader updates.
- Worked on edits to the project management plan (PMP).
- Completed deliverables and milestones in May:
  - April monthly update
  - Task 2: D17 – General Audience CO_2 Sequestration Outreach PowerPoint Presentation

- Task 6: D85 – Opportunities and Challenges Associated with CO_2 Compression and Transport During CCS Activities
- Task 9: D69 – Best Practices for Modeling and Simulation of CO_2 Storage
- Task 14: D101 – Water Working Group Web Site Content Update

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

Highlights

- Submitted D101 entitled "Water Working Group Web Site Content Update" on May 23, 2017, for review and received approval on May 25, 2017.
- Continued work on D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS), including the following:
  - Worked on an annotated outline.
  - Worked on a schedule for the development of D107.
- Discussed the upcoming quarterly conference call and 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

- April 27 – May 4, 2017: traveled to Abu Dhabi, UAE, to attend the CSLF 2017 Mid-Year Meeting.
- May 6–10, 2017: traveled to Oklahoma City, Oklahoma, to attend the IOGCC Annual Meeting.
- May 13–21, 2017: traveled to Calgary, Alberta, Canada, to present at Geoconvention 2017.
- May 21–25, 2017: traveled to San Francisco, California, to host the PCOR Partnership TAB Annual Meeting.
- May 25–27, 2017: traveled from San Francisco, California, to Metro Park, California, to attend the 2017 SCCS Affiliates Meeting & Workshop at Stanford University.

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