



Plains CO₂ Reduction (PCOR) Partnership
Energy & Environmental Research Center (EERC)

Plains CO₂ Reduction (PCOR) Partnership Monthly Update October 1–31, 2017

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Continued activities to update the content of the **Plains CO₂ Reduction (PCOR) Partnership partners-only Decision Support System (DSS) Web site**, including the following:
 - Uploaded all 2017 PCOR Partnership Annual Membership Meeting presentations to the PCOR Partnership members-only DSS Web site and sent an e-mail to all partners in attendance.
 - Continued preparing files from the 2015 PCOR Partnership Annual Membership Meeting for the page.
 - The 2016 PCOR Partnership Annual Membership Meeting to the PCOR Partnership Annual Meetings sections are now live.
 - Continued work on the Bell Creek sections following approval by Denbury.
 - Created GIS (geographic information system) files for the latest update to the CO₂ emissions sources in the PCOR Partnership region (from Deliverable [D]1 – Review of Source Attributes) and prepared files for use in the PCOR Partnership members-only DSS interactive map.
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
 - Updated North Dakota, South Dakota, and Manitoba monthly production data.
 - Updated North Dakota, South Dakota, Montana, Nebraska, Manitoba, and Saskatchewan well information.
 - Continued database preventive maintenance of Petra projects.
- Continued work on regional models, including compilation of characterization data for the Fryburg and Medora Heath–Madison fields.
- Began a storage resource assessment of the western Nebraska/eastern Colorado region.
- With regard to **Williston Basin** CO₂ Storage Sink Relative Permeability Laboratory Characterization:
 - Continued modification to the value-added report based on internal review.
- With regard to the **Aquistore** project’s static modeling and dynamic predictive simulations effort:
 - Submitted D93 entitled “Aquistore CO₂ Storage Project: Numerical Modeling and Simulation Update” on October 7, 2017, for review. Received approval on October 10, 2017.

- Hosted Petroleum Technology Research Centre (PTRC) CEO Dan MacLean on October 13, 2017. Discussed Energy & Environmental Research Center (EERC) and PTRC activities and provided a tour of the EERC facilities.

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

Highlights

- Submitted D14 entitled “PCOR Partnership – Demonstrating CO₂ Storage in the Northern Great Plains” on October 3, 2017, for review. Received approval with minor edits on October 4, 2017.
- Submitted a value-added fact sheet update entitled “Carbon Dioxide and Climate Change” on October 3, 2017, for review. Received approval on October 4, 2017.
- Submitted D15 entitled “Bell Creek Project – Enhanced Oil Recovery with Associated CO₂ Storage” on October 7, 2017, for review. Received approval on October 10, 2017.
- Submitted a request for review and received approval on October 6, 2017, of updates to the PCOR Partnership public Web site. Approved updates went live on October 10, 2017, including the following:
 - CO₂ Sequestration Projects page: On the hover boxes, updated CO₂ injection information and added a “Project Status” line. Updated print-friendly PDF.
 - Aquistore: Updated text, replaced image with newer version on the PTRC Web site.
 - Boundary Dam Project: Updated text.
 - Fort Nelson Project: Updated text.
 - Weyburn–Midale: Updated text.
 - Climate Change, CO₂, Sequestration page: Updated and revised text, subdivided bulleted hyperlinks into two categories.
- With regard to **Documentary D22** (Coal Powered):
 - Reviewed and assessed comments by EERC staff members from the September 12, 2017, viewing of the draft documentary and from the U.S. Department of Energy (DOE).
 - Prepared a master list of suggested revisions.
 - Initiated recommended edits for Prairie Public Broadcasting (PPB).
- With regard to **Documentary D21** (The Bell Creek Story – CO₂ in Action):
 - Finalized edits for clips intended for use on the PCOR Partnership public Web site and in presentations. Prepared edits for PPB. PPB’s submittal of the documentary to the National Educational Telecommunications Association (NETA) for national distribution is under way.
- Updated the DOE-approved Bell Creek Test Site fact sheet (D15) incorporating the changes requested by Denbury.
- Updated a DOE-approved value-added fact sheet title to “Carbon Capture Utilization and Storage Outreach” and printed copies for distribution at the PCOR Partnership Annual Meeting.
- Continued writing text for the draft updated Phase II Zama fact sheet.
- Participated in the monthly Outreach Working Group (OWG) conference call on October 19, 2017. Topics included upcoming speakers for calls and the content of a feedback form for outreach leads regarding the OWG and the value of its activities since inception.

- Continued work on the PCOR Partnership public Web site for D13 (Public Site Updates) due January 2018, including updated draft descriptions and categories for the Video Clip Library Web pages.

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

Highlights

- Participated in the Interstate Oil and Gas Compact Commission (IOGCC) Annual Meeting held September 30 – October 4, 2017, in Pittsburgh, Pennsylvania. Served as the cochair during two Safety and Environmental Committee meetings.

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

- Provided three nonconfidential EERC reports on research performed on membranes to a PCOR Partnership partner, as requested at the PCOR Partnership Annual Meeting.

Task 7 – CO₂ 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 October 4, 2017, regarding official updated volumes of metric tons of CO₂ purchased for injection and metric tons of CO₂ stored at Bell Creek. As of August 31, 2017, the most recent month of record, 4.220 million tonnes of total gas (composition of approximately 98% CO₂) has been purchased for injection into the Bell Creek Field, equating to an estimated **4.158 million tonnes of CO₂ stored**. At the end of BP4, 2.979 million tonnes of CO₂ had been stored.
- Held a project update meeting with Denbury representatives on October 23, 2017, in advance of the PCOR Partnership Annual Membership Meeting and Workshop. Topics of discussion

included Bell Creek technical activities, pulsed-neutron log (PNL) logs, geophysics, InSAR, and the site closure/decommissioning plan.

- Submitted D51 entitled “Best Practices Manual – Monitoring for CO₂ Storage” on October 31, 2017, as a draft. This report is undergoing technical expert review with changes expected. A revised draft will be submitted.
- 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. Continued work on revisions to lessons learned, recommended best practices, case studies, and text.
- Worked on abstracts for consideration at GHGT-14 to be held October 21–26, 2018, in Melbourne, Australia.
- Met internally to discuss plan to upload PCOR Partnership data to the National Energy Technology Laboratory’s (NETL’s) Energy Data eXchange (EDX) in 2018.
- **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 Phase Areas 1–3. Predictive simulation is complete for Phase Areas 1 and 2. Long-term simulations of CO₂ migration are complete for Phase Areas 3–7.
 - ◆ History matching of the simulation model is complete for the waterflooding and CO₂-flooding stages for Phase Area 4 using the simulation model based on the Version 3 geologic model.
 - ◆ Updated the production data in the Bell Creek Phase 4 simulation model to August 2017 and predicted the CO₂ plume distribution in the phase to October 2017.
 - ◆ Continued work on simulation models for PNL match.
 - Coordinating with Denbury and Schlumberger on the potential acquisition of time-lapse PNL saturation logs in three wells that have seen gas breakthrough. The acquisition is planned to be concurrent with a time-lapse 3-D seismic survey and could aid in building a seismic amplitude change to CO₂ saturation correlation. Received an updated bid from Schlumberger for logging PNLs in three wells.
 - Continued work on tying seismic attributes from the three sets of seismic difference data to the PNL well data. Worked on seismic inversion of the 2012 baseline and applied to wavelet analysis to the 2012 baseline, 2012 overlap on 2014, and 2014 overlap on 2012 data.
 - Continued work with InSAR data evaluation.
 - Used the most recent publicly available data to determine that cumulative CO₂ gas injection is 8,236,960 tonnes through August 31, 2017. This value represents the total gas injected, which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 98% CO₂ (Table 1).

Table 1. Bell Creek CO₂ Gas Injection Totals for August 2017 (cumulative totals May 2013 to August 2017)¹

	August 2017 Injection
Total, Mscf	5,178,776
Total, tons ²	296,218
Total, tonnes ³	268,985
Cumulative Total, Mscf ⁴	158,586,186
Cumulative Total, tons ^{2,4}	9,070,879
Cumulative Total, tonnes ^{3,4}	8,236,960

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 August 31, 2017, the most recent month of record, 4.220 million tonnes of total gas (composition of approximately 98% CO₂) has been purchased for injection into the Bell Creek Field, equating to an estimated 4.158 million tonnes of CO₂ stored (Table 2), with the difference comprising other trace gases in the purchase gas stream. A separate method from that used to calculate estimated total gas injected was used to calculate a cumulative associated CO₂ storage by correcting the gas purchase volume (approximately 98% CO₂) obtained from Denbury's custody transfer meter with gas compositional data.
- Continued to work with Denbury on the collection of the eighth round of oil samples from a select group of wells in the Bell Creek Field.
- A summary of all oil and CO₂ gas stream samples collected for analyses to date is provided in Table 3.

Table 2. Cumulative Total Gas Purchased and Estimated Associated CO₂ Storage for the Bell Creek Field¹

	August 2017 Gas Totals
Monthly Total Gas Purchased, MMscf ²	2053
Monthly Total Gas Purchased, million tons ²	0.117
Monthly Total Gas Purchased, million tonnes ²	0.107
Cumulative Total Gas Purchased, MMscf ^{2,3}	81,243
Cumulative Total Gas Purchased, million tons ^{2,3}	4.647
Cumulative Total Gas Purchased, million tonnes ^{2,3}	4.220
Cumulative Total CO ₂ Stored, MMscf ^{3,4}	80,056
Cumulative Total CO ₂ Stored, million tons ^{3,4}	4.579
Cumulative Total CO ₂ Stored, million tonnes ^{3,4}	4.158

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 CO₂ stored **CORRECTED** for gas composition.

Table 3. Oil and CO₂ 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
Feb 2017 ²		O	O		O	O	O	O	O	O
May 2017 ²	PR	O	O	O	O	O	O	O	O	O
July 2017 ²		O			O	O	O	O	O	O
Oct 2017				O			O	O	O	O

¹ P = purchase CO₂ gas stream, R = recycle CO₂ gas stream, O = produced oil stream, and G = produced CO₂ gas stream.

² Oil samples collected but not yet analyzed.

Task 10 – Site Closure (John A. Hamling)

Highlights

- Completed draft abstract and outline for D54 (Site Closure Procedures).

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

Highlights

- Completed draft abstract and outline for D73 (Monitoring and Modeling Fate of Stored CO₂).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Continued updating sections in the BP5 Program Year 10 annual report based on deliverables and milestones.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Extended PCOR Partnership Phase III to December 31, 2018, in Amendment 37, on October 1, 2017.
- Effective October 5, 2017, William (Bill) Aljoe replaces Andrea Dunn as the PCOR Partnership Program Manager.
- Received approval for D103 entitled “PCOR Partnership Best Practices Manual for Subsurface Technical Risk Assessment of Geologic CO₂ Storage Projects” on October 3, 2017.
- Attended the Global CCS Symposium – Advancing a Path Forward held October 3–5, 2017, in Regina, Saskatchewan.
- Hosted the PCOR Partnership Annual Membership Meeting and Workshop October 24–26, 2017, in Plano, Texas. The workshop and meeting were well attended and received. EERC researchers representing each of the active tasks attended and/or participated in the workshop and meeting. A total of 98 attendees (71 partners, presenters, or guests) from 46 organizations were in attendance (see Figure 1).
- Hosted a PCOR Partnership Technical Advisory Board (TAB) meeting in conjunction with the PCOR Partnership Annual Membership Meeting and Workshop on October 24, 2017. Five TAB members were able to attend. Topics of discussion included ongoing efforts and deliverables and key messages of the PCOR Partnership.
- Attended the American Institute of Chemical Engineers (AIChE) Annual Meeting held October 29 – November 3, 2017, in Minneapolis, Minnesota. Presented “Geologic Storage of Carbon Dioxide in the Central Plains of North America.”
- Received recommendations resulting from the IEA Greenhouse Gas R&D Programme (IEAGHG) peer review of the Regional Carbon Sequestration Partnership Initiative Development Phase (Phase III) performed January 23–27, 2017. Responses to each recommendation are being drafted by the PCOR Partnership team.



Figure 1. 2017 PCOR Partnership Annual Membership Meeting attendees.

- Continued work on a planned special issue of *International Journal of Greenhouse Gas Control*. Team members continued writing text for potential papers.
- Continued to develop a list of potential abstracts for submission to GHGT-14 to be held October 21–26, 2018, in Melbourne, Australia.
- Responded to several inquiries received from PCOR Partnership members following the PCOR Partnership Annual Membership Meeting and Workshop. These inquiries included requests for copies of the workshop activity cards and PCOR Partnership products (e.g., figures, Best Practices Manuals). All requested materials were provided.
- Held a task leader meeting October 18, 2017. Topics discussed included planning for the 2017 PCOR Partnership Annual Membership Meeting and Workshop; deliverables, planned journal articles and conference papers; recent meeting attendance, and task updates.
- Held PCOR Partnership Annual Membership Meeting and Workshop planning meetings on October 6 and 13, 2017.
- Completed deliverables and milestones in October:
 - September monthly update
 - Task 1: D93 – Aquistore CO₂ Storage Project: Numerical Modeling and Simulation Update
 - Task 2: D14 – PCOR Partnership – Demonstrating CO₂ Storage in the Northern Great Plains
 - Task 2: D15 – Bell Creek Project – Enhanced Oil Recovery with Associated CO₂ Storage
 - Task 9: D51 – Best Practices Manual – Monitoring for CO₂ Storage

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

Highlights

- Attended the Asia–Pacific Economic Cooperation (APEC) Water–Energy Nexus Expert workshop held October 31 – November 2, 2017, in Atlanta, Georgia.
- Continued development of the draft D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS). Reiterated the request for input from WWG members. Received input from a member; reviewing content for inclusion in the draft.
- Distributed the notes from the June conference call and the WWG Annual Meeting held August 2, 2017. Provided the presentations from the annual meeting.

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO₂ 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

- October 2–4, 2017: traveled to Pittsburgh, Pennsylvania, to attend the IOGCC Annual Meeting and the Environmental & Safety Committee Meeting.

- October 2–5, 2017: traveled to Regina, Saskatchewan, to attend the Global Carbon Capture & Storage Symposium – Advancing a Path Forward.
- October 4–5, 2017: traveled to Bismarck, North Dakota, to attend the Lignite Energy Council 2017 Fall Conference.
- October 22–27, 2017: traveled to Plano, Texas, to attend a meeting at Denbury headquarters; to host, attend, and present at the 2017 PCOR Partnership Annual Membership Meeting and Workshop; and to host the TAB meeting.
- October 30 – November 2, 2017: traveled to Atlanta, Georgia, to attend the Water–Energy Nexus Expert Workshop.
- October 31 – November 3, 2017: traveled to Washington, D.C., to attend the Midwest Regional Carbon Sequestration Partnership Meeting and events.

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