Plains CO_2 Reduction (PCOR) Partnership Monthly Update
August 1–31, 2016

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Submitted a request on August 22, 2016, to extend Deliverable (D) 81, the PCOR Partnership Atlas update, to December 31, 2016. The request was approved August 24, 2016.
- Continued efforts to update D81, PCOR Partnership Atlas (update), including the following:
  - Prepared draft text and data on enhanced oil recovery (EOR) potential in the PCOR Partnership region for an update to the corresponding CO_2 EOR page.
  - Continued modifying the existing chapters.
  - Continued to create content for the last remaining blank pages in the Atlas.
  - Continued internal review process.
- Updated information and continued work on the partners-only Decision Support System (DSS) Web site. Modified the pop-up boxes for the oilfield layer of the DSS interactive map. Discussed a time line with the Energy & Environmental Research Center (EERC) programmers to add features to the DSS interactive map. Seven saline layers and the associated storage values are ready for addition.
- Worked on the 2016 D1, Review of Source Attributes (update), due September 30, 2016, including the following:
  - Downloaded data from the U.S. Environmental Protection Agency (EPA) and Environment Canada and imported into the database.
  - Worked on quality assurance checks on the raw data. Each CO_2 source's emission value and other information (location, noncombustion CO_2 emissions, and other greenhouse gas and SO_x/NO_x emissions) are compared to values from the prior year. If necessary, additional searching is performed to be able to update the source's status.
- Prepared a map and accompanying table of current CO_2 capture projects (demonstration and commercial scale), including quantity of CO_2 captured, in the United States to fulfill a request by a PCOR Partnership member.
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota and Montana Petra projects with the latest well, production, and injection information from each state's online resources: 106 new North Dakota wells and one new Montana well added.
  - Updated South Dakota, British Columbia, and Manitoba projects.
  - Continued database preventive maintenance of Petra projects.
  - Worked on processing an updated Wyoming state well data set.

- Continued work on regional models, including the following:
  - Searched for top and log data to construct a model of the Duperow Formation.
  - Modified the model to include the entire Beaver Creek Field. Assigned lithofacies to the wells and upscaled the logs. Added permeability and porosity values.
  - Began digitizing needed logs for the Gooseneck Field model.
- With regard to the **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued relative permeability calculations and curve plotting. Worked on validating the relative permeability curves.
  - Worked on the final value-added report and a technical paper to be submitted to the Greenhouse Gas Control Technologies (GHGT)-13 Conference.
  - Reviewed microcomputerized tomography (CT) scan data received from a representative from North Dakota State University for two post-relative permeability samples. The CT scans did show internal flow pathways that had developed through erosion/dissolving during relative permeability testing.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Arranged and participated in a Webinar with Computer Modelling Group Ltd. (CMG) on August 2, 2016, to discuss Aquistore simulation and possible work on geomechanical modeling in GEM.
  - Participated in a conference call on August 8, 2016, with representatives from CMG, the University of Alberta, and Petroleum Technology Research Centre (PTRC) to discuss proposed modeling efforts.
  - Participated in a Science and Engineering Research Committee (SERC) conference call on August 10, 2016. Injection has resumed at a rate of 300–500 tonnes a day. Total CO_2 injection to data is approximately 78,500 tonnes.
  - Presented a simulation update at the Aquistore Annual Technical Meeting held August 16, 2016, in Ottawa, Ontario, Canada.
  - Continued writing manuscripts for upcoming GHGT-13 and American Institute of Chemical Energineers (AIChE) Conferences.
  - Continued to download and process injection and pressure data as available.
  - Constructed a new simulation model utilizing the new static model with seismic inversion data. Initial history match efforts suggest that the rock physical properties in the model may need to be modified.

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

<u>Highlights</u>

- Received approval for D13, Public Site Updates, on August 25, 2016.
- Submitted a draft value-added Phase II fact sheet update entitled "CO_2 Sequestration Test in a Deep, Unminable Lignite Seam," on August 25, 2016.
- Submitted D16, Fort Nelson Test Site fact sheet (update) on August 31, 2016.
- Completed draft updates for three fact sheets (PCOR Partnership Prospectus III, What is the PCOR Partnership?, and Aquistore).
- Completed a task-level review of the draft updated Phase II Zama fact sheet.
- Continued revising draft text for a value-added update of the Phase II Terrestrial fact sheet.

- Continued preparation of drafts for the two papers related to presentations accepted for the GHGT-13 Conference.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Continued work on future updates to several pages. Prepared print-friendly pages and video clip images. The changes made by the programmers are being reviewed.
  - Continued ongoing identification and repair of broken links.
- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - Documentary D21 (The Bell Creek Story):
    - Continued script and interview question development.
    - Traveled to the PPB studios in Fargo, North Dakota, on August 22, 2016, to perform an interview with Tom Doll, an off-site team member, pertaining to carbon capture and storage (CCS) and CO_2 EOR processes, similarities and differences, and regulations.
    - Confirmed a September 12, 2016, interview with Nick Azzolina, The CETER Group (CETER), at the EERC.
    - Finalized and distributed interview questions to Tom Richmond, Montana Board of Oil and Gas Conservation; Nick Azzolina, CETER; and Steve Melzer, Melzer Consulting.
  - Documentary D22 (Coal and the Modern Age):
    - Conducted an interview with Sean Adams, University of Florida, in Gainesville, Florida, on August 17, 2016. Reviewed two publications on coal use history by Sean Adams as a basis for preparing questions for the interview with the author.
    - Initiated content review of three relevant books.

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

Highlights

- Continued working on the regulatory permitting document for the PCOR Partnership region (D76 – Regional Regulatory Perspective). The goal of this document is to help PCOR Partnership states and provinces through the permitting process.
  - Continued research of Canadian National Energy Board, British Columbia, Saskatchewan, Alberta, Manitoba, and U.S. EPA CCS and carbon capture, utilization, and storage regulations.
  - Continued task-level review and edit of the draft report.
  - Discussed review changes with a consultant from CETER.
- Removed electrical panels and filed sundry notice for the reclamation of the lignite site in Burke County, North Dakota.

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

Highlights

- **Bell Creek** test site activities included the following:
  - Continued work on the PCOR Partnership Site Characterization Best Practices Manual (BPM) (D35) outline and executive summary. Continued efforts to ensure consistency with D102– Adaptive Management Approach BPM.

- Worked on renewing several Schlumberger software licenses that expired. These licenses are needed to continue the static modeling work conducted under this task.
- Began preparing a geology/geomodeling poster for display at the PCOR Partnership Annual Membership Meeting and Workshop.
- Continued work on **modeling**, including the following:
  - Began work on petrophysical property investigations for the Version 3 model using facies logs.

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

- Attended the DOE NETL CO_2 Capture Technology Project Review Meeting, August 8–12, 2016, in Pittsburgh, Pennsylvania,. Topics covered by the technical talks relevant to Task 6 included advances in technologies for pre- and postcombustion, oxycombustion, and compression.
- Continued to edit text of the summary in the update of the 2011 CO_2 capture technologies overview document to reflect status changes, new vendor information, etc.

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 August 31, 2016, 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 July 31, 2016, the most recent month of record, 3.247 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 ***3.192 million tonnes of CO_2 stored***.
- Received approval on August 24, 2016, for a change of scope request and Milestone (M) 55 title change, which was submitted on August 4, 2016. The EERC and Denbury Onshore (Denbury) propose to perform oil sampling and analysis activities at Bell Creek in lieu of tracer surveys. The title of M55 (formerly "Initial Tracer Analysis Completed") will be changed to "Investigation of Crude Oil Compositional Changes During CO_2 EOR Completed." The planned date of milestone completion is September 30, 2017.

- Submitted a revision of D66 (Bell Creek Test Site – Simulation Report [Update 4]) on August 25, 2016, with comments from Denbury incorporated. Update 4 of D66 was originally submitted for DOE review on August 27, 2015.
- Submitted the D66 (Bell Creek Test Site – Simulation Report [Update 5]) executive summary on August 31, 2016. The report is under concurrent review by Denbury.
- Continued planning a geophysical logging workshop. This Schlumberger-led training will be held at the EERC October 31 – November 4, 2016, and will cover tools, principles, applications, and processing of various geophysical logging techniques that can be used to collect data for modeling and monitoring, verification, and accounting (MVA).
- Worked on preparing presentation, poster, and booth materials for the PCOR Partnership Annual Membership Meeting and Workshop.
- Created a time-lapse seismic image and caption of the Bell Creek Field in a PCOR Partnership project for use in the DOE MVA BPM, as requested by DOE NETL.
- Drafted GHGT-13 conference papers related to 4-D seismic data interpretation, minimum miscibility pressure and oil recovery performance, and MVA activities related to the Bell Creek project.
- Continued work on the life cycle analysis (LCA) of oil produced during EOR compared with oil produced conventionally, including the following:
  - Received data and information from Denbury that can be input into the site-specific Bell Creek Field LCA.
  - Team members working on the Bell Creek Field LCA model coordinated to ensure that all information required to determine the CO_2 emissions (positive or negative) at the Bell Creek Field has been received from Denbury.
  - Requested clarification/verification where necessary to ensure accuracy and understanding of supplied data.
- **Bell Creek** injection-phase site activities included the following:
  - Continued reservoir pressure and distributed temperature monitoring of the 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 working with the Fall 2015 4-D surface seismic data set from Bell Creek, including the following:
    - Well-tie interpretation.
    - Compared processed results for two baseline reprocessed data sets; additional detail is identified in the new seismic map.
    - Worked on developing a revised Bell Creek 4-D surface seismic difference map.
  - Passive seismic monitoring of 04-03 OW using the borehole seismic array has ceased because of equipment failure:
    - The borehole seismic array is nonoperational as the SuperMicro Linux personal computer (PC) that controls the recording drives fails to recognize them, making recording impossible. Repairs will require bringing the SuperMicro to the EERC for reconditioning, planned for late September 2016. The downhole array equipment appears to be intact and functional.
  - Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 5,585,322 metric tons through July 31, 2016. This value represents the total gas

volume injected, which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 98% CO_2 (Table 1).

- As of July 31, 2016, the most recent month of record, 3.247 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 3.192 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.

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

	July 2016 Injection
Total, Mscf	2,924,974
Total, U.S. tons[2]	167,304
Total, metric tons[2]	151,923
Cumulative Total, Mscf [2]	107,534,209
Cumulative Total, U.S. tons[2,3]	6,150,787
Cumulative Total, metric tons[2,3]	5,585,322

Source: Montana Board of Oil and Gas (MBOG) database.

[1] There has been a lag in posting of injection/production volumes to the MBOG database. Total gas injection volumes are ***NOT CORRECTED*** for gas composition and include the combined purchased and recycled gas streams.

[2] This was calculated utilizing a conversion of 17.483 Mscf/U.S. ton and 19.253 Mscf/metric ton.

[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 Volumes for the Bell Creek Field[1]

	July 2016 Gas Volume
Monthly Total Gas Purchased, MMscf[2]	509
Monthly Total Gas Purchased, million tons[2]	0.029
Monthly Total Gas Purchased, million tonnes[2]	0.026
Cumulative Total Gas Purchased, MMscf[2,3]	62,513
Cumulative Total Gas Purchased, million tons[2,3]	3.576
Cumulative Total Gas Purchased, million tonnes[2,3]	3.247
Cumulative Total CO_2 Stored, MMscf[3,4]	61,454
Cumulative Total CO_2 Stored, million tons[3,4]	3.515
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.192

[1] Conversion factors of 17.483 Mscf/ton and 19.253 Mscf/tonne were used to calculate volumes.

[2] Total gas-purchased volumes are ***NOT CORRECTED*** for gas composition.

[3] Cumulative totals are for the period from May 2013 to the month listed.

[4] Total gas CO_2 stored volumes are ***CORRECTED*** for gas composition.

- Coordinated the third round of oil sample collection from a select group of wells in Bell Creek with a representative from Denbury. Sampling was initiated August 29. An EERC representative will travel to Bell Creek toward the end of the sampling effort to collect the final samples and transport those to the EERC.
- A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.
- Completed processing the field meter readings of Fox Hills formation monitoring wells (two samples total) from May 2016.
- Completed analyses of purchase/recycle CO_2 gas samples from the Bell Creek Field sampling trip July 18–22, 2016.
- Completed gas chromatography (GC) of soil gas bags collected on the July 25–29, 2016, field trip. Completed processing of the handheld meter and field GC data.

Table 3. Oil and CO_2 Gas Stream Sampling and Analyses

Stream(s)	Dates Sampled
Production: Oil[1]	Jan. 2014, March 2014,[2] May 2014, June 2014, July 2014, Sept. 2014, Oct. 2014,[2] Jan. 2015,[2,3] May 2015,[3,4] June 2015,[3] Nov. 2015,[3,5] May 2016[6]
Production: CO_2 Gas[1]	Sept. 2014,[2] Nov./Dec. 2014, Jan. 2015,[7] March 2015, July 2015
Purchase/Recycle: CO_2 Gas[8]	May 2014,[9] June 2014, July 2014, Sept. 2014, Oct. 2014, April 2015, July 2015, Sept. 2015, Jan. 2016

[1] Wells 56-14R, 32-02, and 05-06 unless otherwise noted.
[2] Wells 56-14R and 32-02 only.
[3] Samples collected but not analyzed.
[4] Wells 32-02 and 05-06 only.
[5] Wells 56-14R and 05-06 only.
[6] Wells 56-14R, 05-06, 04-04, 28-02, 21-10, and 21-14.
[7] Well 05-06 only.
[8] Both purchase and recycle streams unless otherwise noted.
[9] Purchase stream only.

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

- Received approval on August 9, 2016, to adjust the Bell Creek milestones from the 2013 International Energy Agency Greenhouse Gas R&D Programme (IEAGHG) (FY2014) expert review to match the current PCOR Partnership BP5 due dates of the BPMs associated with the milestones.
- Presented "Plains CO_2 Reduction Partnership: Bell Creek Field Project" at the Mastering the Subsurface Through Technology Innovation & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting in Pittsburgh, Pennsylvania, on August 18, 2016, and attended other presentations and posters throughout the meeting.
- Attended the National Risk Assessment Partnership (NRAP) Risk Assessment Tools Workshop in Pittsburgh, Pennsylvania, on August 15, 2016.
- Presented a PCOR Partnership overview entitled "The Plains CO_2 Reduction Partnership: Developing Technologies for CCS Deployment in Central North America" on August 31, 2016, at the 35th International Geological Congress held August 27 – September 4, 2016, in Cape Town, South Africa.
- Submitted D102/M59 entitled "Best Practice for the Commercial Deployment of Carbon Dioxide Geologic Storage: Adaptive Management Approach" on August 31, 2016. We plan to send a copy of this report to each PCOR Partnership Technical Advisory Board (TAB) member for concurrent review.
- Continued planning the 2016 PCOR Partnership Annual Membership Meeting and Workshop to be held September 13–15, 2016, in Grand Forks, North Dakota, including the following:
  - Held a planning meeting. Discussions included agenda items, evening event logistics, and current registration.
  - Continued modification of the agenda.
  - Confirmed additional speakers, secured sponsorships, chose menu items, configured room setup, and prepared presentation and booth materials.
  - Sent an e-mail blast on August 10, 2016, to notify attendees of the preliminary agenda and remind them of the hotel deadline.
  - Sent an e-mail blast August 25, 2016, reminding attendees of the hotel deadline, registration, and sponsorship opportunities.
  - As of August 29, 2016, 52 attendees were registered from 39 organizations.
  - Coordinated side meetings, including a TAB meeting.
- Completed deliverables and milestones in August:
  - July monthly update
  - Task 2: D16 – Fort Nelson Test Site fact sheet (update)
  - Task 9: D66 – Bell Creek Test Site – Simulation Report (Update 5)
  - Task 13: D102/M59 – Best Practice for the Commercial Deployment of Carbon Dioxide Geologic Storage: Adaptive Management Approach

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

Highlights

- With regard to the *International Journal of Greenhouse Gas Control* (IJGGC) Special Issue:
  - Approved the remaining articles.

  - Continued finalization of the introduction article with a consultant from CETER.
- Hosted the WWG Annual Meeting August 18, 2016, in Pittsburgh, Pennsylvania, as a side meeting during the NETL Mastering the Subsurface Through Technology Innovation & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting. Fifteen individuals participated in the meeting; approximately one-half were represented by WWG members. Presentations were given on the recently awarded Brine Extraction and Storage Test (BEST) projects by Robert Trautz of the Electric Power Research Institute and John Hamling of the EERC. Challenges, potential solutions, and opportunities of both projects were discussed by the group. A novel water treatment technology for high-salinity brines was presented by Vikas Khanna of the University of Pittsburgh. Advantages, disadvantages, and economics of the methodology were discussed by the group.
- Discussed action items from the WWG Annual Meeting with a consultant from CETER.

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

- August 7–12, 2016: traveled to Pittsburgh, Pennsylvania, to attend the DOE NETL CO_2 Capture Technology Project Review Meeting.
- August 14–19, 2016: traveled to Pittsburgh, Pennsylvania, to attend and present at the Mastering the Subsurface Through Technology Innovation and Collaboration: Carbon Storage & Oil and Natural Gas Technologies Review Meeting and to attend the associated NRAP Risk Assessment Tools Workshop.
- August 15–17, 2016: traveled to Ottawa, Ontario, Canada, to attend the Aquistore Annual General Meeting.
- August 16–18, 2016: traveled to Gainesville, Florida, with PPB to conduct an interview with a coal historian for the coal documentary.
- August 22, 2016: traveled to Fargo, North Dakota, to the PPB offices to conduct an interview for the coal documentary.
- August 22–26, 2016: off-site staff member traveled to the EERC offices in Grand Forks, North Dakota, for meetings and to work on upcoming deliverables.
- August 27 – September 2, 2016: traveled to Cape Town, South Africa, to attend and present at the 35th International Geological Congress.

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