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

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Attended the Esri User Conference: Applying the Science of Where, held July 10–14, 2017, in San Diego, California.
- Shipped additional copies of the "Plains CO_2 Reduction (PCOR) Partnership Atlas 5th Edition" (Deliverable [D] 81) to Denbury Resources (Denbury) for distribution.
- 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 well, production, and injection data.
  - Updated South Dakota, Montana, Wyoming, Manitoba, and Saskatchewan well information.
  - Continued database preventive maintenance of Petra projects.
- Continued internal review and modifications on a value-added report on the geologic characterization and CO_2 storage potential of the state of Nebraska. Continued work on the Lodgepole model for the report.
- 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:
  - Participated in a Science and Engineering Research Committee (SERC) conference call on July 6, 2017.
  - Completed work on a history match of the pressure response and well log data.
  - Ran simulation cases to observe plume evolution and pressure response. Worked on analyzing the simulation results.
  - Submitted D93 – Geological Modeling and Simulation Report for the Aquistore Project, to the Petroleum Technology Research Centre (PTRC) on July 31, 2017, for review. Following receipt of PTRC's comments, D93 will be revised and submitted to the U.S. Department of Energy (DOE) by the October 31, 2017, due date.

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

Highlights

- Received approval for Milestone (M) 47 entitled "Bell Creek Test Site – 30-minute Documentary Broadcast" on July 19, 2017.
- Shipped additional copies of Documentary D21 entitled "The Bell Creek Story – CO_2 in Action" to Denbury for distribution.
- Reviewed draft video clips from Documentary D21 entitled "The Bell Creek Story – CO_2 in Action."
- Requested receipt of all DOE review and comments on the draft Documentary D22 entitled "Coal Powered" by August 11, 2017, as a follow-up to a May 2017 request at the direction of Traci Rodosta, DOE National Energy Technology Laboratory (NETL).
- Continued writing text for the draft updated Phase II Zama fact sheet.
- Participated in the monthly Outreach Working Group conference call on July 20, 2017.
- Continued work on updates and revisions to the PCOR Partnership public Web site, including the following:
  - 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
    - Fort Nelson
    - CO_2 Sequestration Project
    - North Dakota CarbonSAFE (Carbon Storage Assurance and Facility Enterprise)
    - CarbonSAFE-Nebraska
    - Wyoming CarbonSAFE
    - Red Trail Energy (Carbon Capture and Storage [CCS] for Ethanol Production)
    - Carbon and CO_2 on Earth
    - Climate Change
    - CO_2 from Human Actions
    - Technical Reports

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

Highlights

- Attended a meeting in Bismarck, North Dakota, on July 7, 2017, with representatives from the North Dakota Industrial Commission (NDIC) Department of Mineral Resources (DMR) Oil & Gas Division and PCOR Partnership partner Red Trail Energy (RTE) to discuss the status of North Dakota's Class VI primacy application and the implications of CCS permitting in North Dakota should it be approved.

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

- A PCOR Partnership representative served as an invited mentor at the 2017 International Energy Agency Greenhouse Gas R&D Programme (IEAGHG) CCS Summer School held July 17–23, 2017, in Regina, Saskatchewan, Canada. Presented "CO_2 Transport."
- Made travel arrangements to attend the DOE NETL CO_2 Technologies Conference to be held in Pittsburgh, Pennsylvania, Aug 21–25, 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 a memo on July 24, 2017, regarding official updated quantities of tonnes of CO_2 purchased for injection and tonnes of CO_2 stored at Bell Creek. As of May 31, 2017, the most recent month of record, 3.939 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 ***3.879 million tonnes of CO_2 stored***. At the end of BP4, 2.979 million tonnes of CO_2 had been stored.
- A PCOR Partnership representative served as an invited mentor at the 2017 IEAGHG CCS Summer School held July 17–23, 2017, in Regina, Saskatchewan, Canada. Presented "Wellbore Integrity."
- Continued work on the best practices manual (BPM) – Monitoring for CO_2 Storage and CO_2 Enhanced Oil Recovery (EOR) (D51), including the following:
  - Refined the outline.
  - Revised text in the monitoring, verification, and accounting overview section.
  - Refined recommended best practices, lessons learned, and case studies and placed in the appropriate sections.
  - Revised and added text in several sections.
- Worked on draft content for D66 Simulation Report Update 6, including writing geologic modeling text, constructing type logs for each geobody, and writing parts of the simulation section, including history matching and predictive simulation case studies.
- 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 CO_2 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, recommended best practices, 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.
  - Worked with a representative from Denbury to set up 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. Traveled to Bell Creek oil field July 10–13, 2017, for borehole array reactivation and check shot acquisition. The upper 25 sensors powered up for recording; the lower 25 channels would not respond to power. Data acquisition was completed successfully from several check shot locations using the 25 active sensors. The borehole array system was powered down, and surface computer and acquisition equipment was returned to the Energy & Environmental Research Center (EERC).
  - 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 Version 3 geologic model.
    - Completed two long-term CO_2 migration simulation cases for Phase Areas 1 and 2.
    - Ran simulation cases for CO_2 EOR and storage prediction in Phase Area 4 using different operating premises.
  - Worked on time-to-depth conversion of the 2012/2014/2015 seismic data set.
  - Continued with interpretation of the results from the relative permeability hysteresis laboratory study to inform simulation model parameters, including the following:
    - Developed relative permeability hysteresis curves for simulation based on oil and gas relative permeability curves measured using CO_2–oil drainage–imbibition cycles performed previously in the lab.
    - Integrated the new relative permeability gas hysteresis curves into simulation models.
  - Used the most recent publicly available data to determine that cumulative CO_2 gas injection is 7,516,219 tonnes through May 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% CO_2 (Table 1).
  - As of May 31, 2017, the most recent month of record, 3.939 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 3.879 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 estimated total gas injected was used to calculate a cumulative associated CO_2 storage 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 May 2017 (cumulative totals May 2013 to April 2017)[1]

	May 2017 Injection
Total, Mscf	3,636,985
Total, tons[2]	208,030
Total, tonnes[3]	188,905
Cumulative Total, Mscf[4]	144,709,768
Cumulative Total, tons[2,4]	8,277,170
Cumulative Total, tonnes[3,4]	7,516,219

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]

	May 2017 Gas Totals
Monthly Total Gas Purchased, MMscf[2]	1355
Monthly Total Gas Purchased, million tons[2]	0.078
Monthly Total Gas Purchased, million tonnes[2]	0.070
Cumulative Total Gas Purchased, MMscf[2,3]	75,832
Cumulative Total Gas Purchased, million tons[2,3]	4.337
Cumulative Total Gas Purchased, million tonnes[2,3]	3.939
Cumulative Total CO_2 Stored, MMscf[3,4]	74,690
Cumulative Total CO_2 Stored, million tons[3,4]	4.272
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.879

[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.

- Worked with Denbury on the seventh round of oil sample collection from a select group of wells in the Bell Creek Field.
- Worked with Denbury to collect purchase/recycle samples in 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

		Production Stream by Development Phase, Well[1]									
	Purchase/	Phase 1				Phase 3			Phase 4		
Date Sampled	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]	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

- Attended the DOE NETL Regional Carbon Sequestration Partnerships (RCSP) Principal Investigator Meeting held July 13, 2017, in Morgantown, West Virginia.
- Attended the Carbon Management Technology Conference 2017 (CMCT 2017) held July 17–20, 2017, in Houston, Texas. Presented "Demonstration of Secure CO_2 Geological Storage Associated with Enhanced Oil Recovery in the PCOR Partnership Region."
- Received acceptance for presentation of the extended abstract entitled "The Plains CO_2 Reduction (PCOR) Partnership: Successes Leading to New Innovation" at the European Association of Geoscientists and Engineers (EAGE) Technical Programme of the Fourth Sustainable Earth Sciences Conference to be held September 3–7, 2017, in Malmö, Sweden.
- Worked on presentation and booth preparations for the 2017 Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage and Oil and Natural Gas Technologies Review Meeting to be held August 1–3, 2017, in Pittsburgh, Pennsylvania.
- Continued development and initiated internal review of the programmatic risk management BPM (D103), which integrates best practices from the Fort Nelson and Bell Creek projects, as well as other CCS-related projects in the PCOR Partnership region.
- 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:
  - Coordinated gift items.
  - Continued development of the draft workshop and meeting agendas.
  - Worked with the hotel events manager on meeting room preparations.
  - Held a planning meeting on July 13, 2017, to discuss workshop format, potential speakers, evening events, food and beverage costs, and participation promotional items.
  - Continued evening event planning.
- Worked on edits to the project management plan.
- Completed deliverables and milestones in July:
  - June monthly update
  - Task 13: D58/D59 – Quarterly Progress Report/Milestone Quarterly Report

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

Highlights

- Continued development of the draft D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS).
- Sent invitations for the WWG Annual Meeting, which will be held August 2, 2017, in Pittsburgh, Pennsylvania. The meeting will be held in the evening so as not to overlap with the concurrent DOE conference. The meeting will host guest speakers to discuss regional perspectives on produced water quantity and quality and wastewater injection capacity. Continued planning efforts. Finalized materials and agenda.

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

- July 7, 2017: traveled to Bismarck, North Dakota, to attend a meeting with NDIC DMR and RTE.
- July 9–14, 2017: traveled to San Diego, California, to attend the ESRI User Conference.
- July 10–14, 2017: traveled to Gillette, Wyoming, for field work and to restart the borehole array.
- July 12–13, 2017: traveled to Morgantown, West Virginia, to attend a meeting at NETL.
- July 15–21, 2017: traveled to Houston, Texas, to present at CMCT 2017.
- July 17–22, 2017: traveled to Regina, Saskatchewan, to assist with the IEAGHG CCS Summer School.
- July 18–19, 2017: traveled to Bismarck, North Dakota, to attend the WBI Energy Customer Meeting and the Rainbow Gas Company Luncheon.
- July 31 – August 4, 2017: traveled to Pittsburgh, Pennsylvania, to attend and present at the Mastering the Subsurface: Carbon Storage & Oil & Natural Gas Technologies Review meeting and to host the WWG Annual Meeting.

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