Plains CO_2 Reduction (PCOR) Partnership Monthly Update
January 1–31, 2018

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Continued activities to update the content of the **PCOR Partnership partners-only Decision Support System (DSS) Web site**, including the following:
  - Uploaded updated CO_2 emission sources GIS (geographic information system) files to the PCOR Partnership partners-only DSS interactive map.
  - Modified draft text of the Bell Creek section of the PCOR Partnership partners-only DSS based on initial internal review.
- Continued work on integrating data for modeling and simulation efforts related to CO_2 storage in mature and depleted oil fields within the region, including the following:
  - Continued to digitize wells for the Fryburg and Medora field models.
  - Continued work on the Lodgepole static model, including completing the structural and facies modeling, beginning the porosity modeling, and adding core data to check porosity and permeability data.
  - Continued work on history matching of field production data for the Gooseneck Field to improve the match of gas production data. Continued work on the simulation. Updated the equation-of-state (EOS) model.
  - Collected well production and perforation data of the Beaver Creek Field. Set up and worked on running a simulation model. Updated the EOS model, and continued history match.
- With regard to **Williston Basin** CO_2 storage sink relative permeability laboratory characterization:
  - Worked on additional internal review of the value-added report.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Received approval from Petroleum Technology Research Centre (PTRC) on January 5, 2018, for a draft abstract for 14th Conference for Greenhouse Gas Control Technologies (GHGT-14) (to be held October 21–26, 2018, in Melbourne, Australia).
  - Downloaded injection data through early January 2018.

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

Highlights

- Submitted a value-added report entitled "Household Energy and Carbon Web Pages Report" for the period of October 1 – December 31, 2017, for review on January 8, 2018.

- Submitted Deliverable (D) 13 entitled "Public Site Updates" for review on January 29, 2018, and received approval on January 30, 2018.
- With regard to **Documentary D22** (working title of Coal Powered):
  - Received and reviewed a draft version from Prairie Public Broadcasting (PPB), noting areas that need adjustments.
    - Sent changes to PPB.
    - Sent PPB instructions and drafts for figures to add to documentary.
    - Sent completed draft narration to PPB.
  - Received and began review of the January 30, 2018, draft version from PPB.
    - Worked on comments.
  - Worked on potential titles to replace the working title of Coal Powered.
  - Began work on promotional content, including DVD jacket text.
- Participated in the monthly Outreach Working Group conference call. The call focused on finalizing the 2018 call schedule, reviewing the subjects for upcoming calls (focus on content for final report), and reviewing two initial workshops (story-telling and risk communication) and the utility of those activities to subsequent partnership outreach activities.
- Continued work on the PCOR Partnership public Web site, including the following:
  - Completed internal review and changes to a page related to PCOR Partnership member Red Trail Energy's carbon capture and storage (CCS) efforts and to the Video Clip Library, Carbon and CO_2 on Earth, and CO_2 Sequestration Projects pages.
  - Added a page related to PCOR Partnership member Red Trail Energy's CCS efforts and video clips from "The Bell Creek Story – CO_2 in Action" in the Video Clip Library to the live Web site on January 22, 2018.
  - Continued internal discussions related to the planned public Web site technical upgrade, including a new template for the Web site.

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

Highlights

- Continued to review information needed for the D8 Permitting Review – Update 4, due February 28, 2018.

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

- Continued preparation of the update of the final version of the CO_2 capture technologies overview value-added document.

- Assisted a PCOR Partnership partner with information to potentially use in its response on the two portions of the U.S. Environmental Protection Agency's Advance Notice of Proposed Rulemaking (for replacement of the Clean Power Plan) related to CCS monitoring, recordkeeping, and reporting.

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 January 25, 2018, regarding official updated quantities of CO_2 purchased for injection and stored at Bell Creek. As of December 31, 2017, the most recent month of record, 4.803 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 ***4.739 million tonnes of CO_2 stored***. At the end of BP4, 2.979 million tonnes of CO_2 had been stored.
- Based on mutual agreement with the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Project Manager, the PCOR Partnership plans to submit update to D69 (Best Practices for Modeling and Simulation of CO_2 Storage), which was submitted May 31, 2017, and to D51 (Best Practices Manual – Monitoring for CO_2 Storage), which was submitted October 31, 2017, that incorporate additional technical expert reviewer perspectives and findings. Continued internal review and modifications to figures and text.
- Continued work on writing papers for the planned special issue of *International Journal of Greenhouse Gas Control* (IJGGC).
- Continued discussions of plans to upload PCOR Partnership data to the NETL's Energy Data eXchange (EDX) in 2018.
  - Participated in a DOE-hosted EDX introductory WebEx on January 22, 2018, explaining the data submission process.
  - A collaborative workspace has been created in EDX for the PCOR Partnership to store data in the future.
- **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 using the simulation model based on the Version 2 geologic model. Predictive simulation is

complete for Phase Areas 1 and 2. Simulations to investigate long-term 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.

- Continued processing the passive seismic data set.
- Used synthetic events to work on the establishment of detectability limits of the downhole array.
- Continued work on relating measured and/or simulated CO_2 thickness at a particular well with the seismic amplitude difference between the baseline and monitoring 3-D seismic.
- Continued work on estimating magnitudes of microseismic events in the Bell Creek Field.
- Continued work on the pressure data history of the wells in Phase Area 4 to improve the geomechanical modeling for use in ground surface deformation modeling and simulation. Continued work with InSAR (interferometric synthetic aperture radar) data evaluation in conjunction with operational data.
- Continued time series analysis to compare dynamic operational data with InSAR deformation. Integrating geomodel grids of porosity–height to assess impact of static reservoir parameters to rate of deformation.
- Evaluated different relationships and constraints for transforming seismic amplitude differences to CO_2 saturation height and generated grids for each scenario. Developed workflow for incorporating gridded amplitude corrections as a consequence to changes in pressure for calculating CO_2 saturation height from seismic amplitude difference.
- Used the most recent publicly available data to determine that cumulative CO_2 gas injection is 8,988,869 tonnes through November 30, 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 December 31, 2017, the most recent month of record, 4.803 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 4.739 million tonnes of CO_2 stored (Table 2),

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

	November 2017 Injection
Total, Mscf	5,381,696
Total, tons[2]	307,828
Total, tonnes[3]	279,525
Cumulative Total, Mscf[4]	173,062,702
Cumulative Total, tons[2,4]	9,898,913
Cumulative Total, tonnes[3,4]	8,988,869

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]

	December 2017 Gas Totals
Monthly Total Gas Purchased, MMscf [2]	3929
Monthly Total Gas Purchased, million tons[2]	0.225
Monthly Total Gas Purchased, million tonnes[2]	0.204
Cumulative Total Gas Purchased, MMscf [2,3]	92,474
Cumulative Total Gas Purchased, million tons[2,3]	5.289
Cumulative Total Gas Purchased, million tonnes[2,3]	4.803
Cumulative Total CO_2 Stored, MMscf [3,4]	91,238
Cumulative Total CO_2 Stored, million tons[3,4]	5.219
Cumulative Total CO_2 Stored, million tonnes[3,4]	4.739

[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.

- 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 Onshore's (Denbury's) custody transfer meter with gas compositional data.
- Completed collection of the ninth round of oil samples from a select group of wells in the Bell Creek Field with Denbury personnel. Two samples broke in transit. Resampled one well to complete collection.
- A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.
- Completed oil composition analyses of oil samples collected from Bell Creek Oil Field from Phase Areas 1 and 4. Began working on data analyses.

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

- Submitted D73 entitled "Applied Modeling, Forecasting, and Monitoring of the Fate of Injected CO_2 for the Management of Geologic CO_2 Storage" on January 31, 2018. This deliverable will also serve as a GHGT-14 paper upon acceptance from the conference. The deliverable was sent to Denbury for concurrent review.

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]	PR	O	O	O	O	O	O	O	O	O	O
July 2017[2]		O			O	O	O	O	O	O	O
Oct 2017				O			O	O	O	O	O
Nov 2017		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 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Received approval for D57 entitled "Annual Assessment Report" on January 1, 2018.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Received approval for Milestone (M) 65 entitled “PCOR Partnership Annual Membership Meeting and Workshop Held” on January 1, 2018.
- Submitted abstracts under several tasks for consideration at GHGT-14 to be held October 21–26, 2018, in Melbourne, Australia, listed in Table 4. PDF files were provided to the DOE Project Manager.
- Submitted a PCOR Partnership overview abstract to the International Brown Coal Mining Congress, which will be held in Betchatow, Poland, April 16–18, 2018. The conference will

Table 4. GHGT-14 Abstracts Submitted for Consideration

Title	Task
Clarifying the Relationship Between Enhanced Oil Recovery and the Associated Storage of Injected CO_2	9
Determining the Long-Term Fate of CO_2 Storage Associated with an Enhanced Oil Recovery Project	9
Passive Microseismic Monitoring of CO_2 EOR and Associated Storage Using a Downhole Array in a Noisy Subsurface Environment	9
An Improved Numerical Modeling and Simulation Study of the Aquistore CO_2 Storage Project	1
Applications and Benefits of Observation Wells for Commercial CO_2 Storage	9
PCOR Partnership Outreach: An Evolving Regional Capability Based on RCSP Outreach Best Practices	2
Nexus of Water and CCS: Findings of the Water Working Group (WWG) of the Regional Carbon Sequestration Partnerships	14
Viability of InSAR as a Monitoring Tool in Challenging Terrain: Bell Creek, Montana	9
Successes and Lessons Learned from 15 Years of the PCOR Partnership	13
Applied Modeling and Monitoring of the Fate of Injected CO_2 for the Management of Geologic Storage	11
Evaluation of Measured Differences in Liquid Versus Gas Permeability and Identification of Potential Causes	9

include discussion of modern CCS technologies. If the abstract is accepted, a short paper will be written and presented at the conference.

- Continued work on a planned special issue of IJGGC. Team members continued writing text for potential papers related to all active tasks. Worked on internal reviews.
- Worked on planning the PCOR Partnership Technical Advisory Board (TAB) annual meeting to be held April 9–11, 2018, in Miami, Florida. Contract negotiations have begun with the selected hotel. Potential agenda topics are being considered.
- Began discussions on the timing and location for the 2018 PCOR Partnership Annual Membership Meeting and Workshop. Currently looking into Grand Forks, North Dakota, in September 2018 or Washington, D.C., in October 2018.
- Held a task leader meeting January 12, 2018. Topics discussed included deliverables, including planned journal articles and conference papers, best practices manuals, the final report, and task updates.
- Completed reporting in January:
  - December monthly update
  - Task 2: D13 – Public Site Updates
  - Task 11: D73 – Applied Modeling, Forecasting, and Monitoring of the Fate of Injected CO_2 for the Management of Geologic CO_2 Storage

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

Highlights

- Continued development of the draft D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS), including the following:
  - A GHGT-14 abstract was submitted entitled "Nexus of Water and CCS: Findings of the Water Working Group (WWG) of the Regional Carbon Sequestration Partnerships."
  - A draft of the accompanying GHGT-14 paper was sent to the WWG for review and comments on January 29, 2018. As previously approved by the DOE NETL Project Manager, this deliverable will also serve as a GHGT-14 paper upon acceptance from the conference.
- Scheduled the final quarterly conference call for February 6, 2018.

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

- January 8–12, 2018: Off-site staff traveled to Grand Forks, North Dakota, for project activities and a meeting.

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