Plains CO_2 Reduction (PCOR) Partnership Monthly Update
June 1–30, 2015

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Attended an ESRI ArcGIS Pro Webinar.
- Discussed the development of new value-added geologic evaluations for the Williston and Powder River Basins.
- Participated in the weekly U.S. Department of Energy (DOE) Site Characterization best practices manual (BPM) conference call.
- Updated information and continued work on the partners-only decision support system (DSS) Web site:
  - Made a few corrections/modifications. Additional changes and an update of carbon dioxide (CO_2) sources will occur within the next month.
  - Continued database preventive maintenance of Petra projects.
  - Updated North Dakota and Montana Petra projects with the latest general well information from each state's online resource: 171 new North Dakota wells and six new Montana wells were added.
  - Imported Wyoming log data (LAS files).
  - Updated North Dakota monthly production.
  - Updated British Columbia, South Dakota, Saskatchewan, and Manitoba projects.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Held a planning meeting to discuss objectives and path forward for Aquistore simulations and history matching. Will begin working on a value-added report regarding this work and how it supports Aquistore monitoring activities.
  - Continued working on history-matched model and predictive simulations. Attempting to improve model efficiency by using a different grid system. Simulations have been focused on investigating near-wellbore effects during injection.
  - A graduate student intern began working on Aquistore modeling to investigate the differences between the original static model and the current history-matched dynamic model. This information will be used to update the static model.
  - Successfully history-matched the bottomhole pressure of the injection and observation wells based on known field pressure/injection data. Predictive simulations are being conducted.
  - Worked on adjusting the model's parameters (i.e., permeability) based on core data. Investigated the effect of relative permeability on model performance.

- The current static geologic model will be compared to the history-matched model to analyze which parameters were changed to achieve a history match. This information will be used to update the model.
- Film from the ribbon cutting is being put in a format to review.
- Updated the Aquistore model using the latest injection data. History-matched the injection pressure and predicted CO_2 plume distribution profile. Investigated the effect of the presence of an aquifer on injection.
- Worked on updating the reservoir model properties by analyzing core sample data and log data. Permeability values in the simulation model will be updated to ensure more accurate predictive simulations.
- Continued to update the database with daily injection data from the Petroleum Technology Research Centre (PTRC).
- Held the monthly Aquistore update meeting.
- Modified the simulation model grid near the observation well. This will lead to more realistic results regarding CO_2 breakthrough.
- Updated the model with field data and operational parameters, conducted simulations to predict CO_2 breakthrough based on target injection rate, and investigated the near-wellbore effects.
- Created a draft abstract for the DOE Carbon Storage R&D Program Review Meeting based on modeling and simulation work, including the recent history-matching efforts.

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

Highlights

- Submitted an update to Deliverable 17 (D17), entitled "General Phase III Information PowerPoint." Approval was received from the DOE National Energy Technology Laboratory (NETL).
- Prepared and submitted a draft abstract to the DOE Carbon Storage R&D Program Review Meeting in August for a poster presentation.
- Took part in the monthly Regional Carbon Sequestration Partnership (RCSP) Outreach Working Group (OWG) conference call; the call focused on the ongoing preparation of the BPM.
- Initiated the preparation of a summary of PCOR Partnership experience with outreach tracking and metrics for the RCSP Outreach BPM and provided written comments to the OWG regarding the ongoing preparation of the BPM.
- Corresponded by e-mail with Aquistore personnel about the potential for collaborating on an outreach paper for the Laussane International Energy Agency Greenhouse Gas (IEAGHG) meeting in September 2016.
- Continued efforts to expand the type and presentation of statistics for overall past outreach activities and for planning.
- Continued to revise the draft Phase II project fact sheets, including meetings with project personnel to discuss content, with a focus on addressing comments from senior management regarding Northwest McGregor and the results section regarding the Lignite fact sheet.
- Traveled to Bismarck, North Dakota, to present at the Lignite Energy Council Teacher Workshop on June 16, 2015. Distributed packets to the 110 teachers attending the presentation.

- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Continued ongoing identification and repair of broken links.
  - Continued efforts to revise and update the carbon cycle page on the public Web site, focusing on graphics and interactive elements.
  - Reviewed the "live on stage server" version of Batch 1 of the PCOR Partnership public Web page updates.
  - Addressed review comments on the current batch of Web pages.
- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - Completed documentary D22 interviews in New York City, New York, and Arlington, Virginia, and location filming in New Jersey and Pennsylvania, May 31 – June 3, 2015.
  - Completed documentary D22 interviews and location filming with PPB, June 8–12, 2015, in western Pennsylvania.
  - Continued preparations for filming in relation to documentary D22, including an interview at the Energy & Environmental Research Center (EERC) tentatively scheduled for mid-July.
  - Traveled to Fargo, North Dakota, to meet with Prairie Public Education Services regarding a presentation at an upcoming Teacher Training Institute scheduled for late June in Moorhead, Minnesota.
  - Traveled to Meridian, Mississippi, to complete documentary D22 interviews and location filming with PPB, June 22–25, 2015, at the Kemper County Energy Facility in DeKalb, Mississippi, and the nearby Liberty Mine.
  - Traveled to Moorhead, Minnesota, to present at Prairie Public's Teacher Training Institute, June 23–24, 2015. Provided a presentation on Energy, Quality of Life, CO_2, and Carbon Capture and Storage (CCS) that led into a workshop activity based on the PCOR Partnership presentation. Distributed documentaries, the PCOR Partnership Atlas, and other materials.
  - Traveled to White Salmon, Washington, June 29 – July 1, 2015, for a documentary D22 interview.
  - Finalized Video Education Series Part 2, and uploaded to Prairie Public Services Learning Media on June 22. It is available at http://prairiepublic.pbslearningmedia.org/ resource/ 3c031e45-dbcb-4dc3-9037-71982dc69346/dan-daly-presentation-part-2-energy-pcor-eerc/.
  - Completed and closed-captioned education presentation video series Part 1: Energy and Carbon.

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

Highlights

- Continued planning the 2015 PCOR Partnership Regulatory Roundup scheduled for July 22–23, 2015, in Deadwood, South Dakota, including preparing a draft agenda, confirming potential speakers, and sending an e-mail blast.

- Continued gathering information for value-added report on rules, regulations, and statutes for various scenarios of CCS geologic storage and for CO_2 enhanced oil recovery (EOR) for each of the PCOR Partnership states and provinces.
- Prepared and submitted a draft abstract for the DOE Carbon Storage R&D Program Review Meeting.
- Continued reviewing notes from the Interstate Oil and Gas Compact Commission (IOGCC) Environment and Safety Committee meeting.
- Reviewed notes from the 2015 Carbon Capture, Utilization, and Storage Conference to prepare for a presentation at the upcoming PCOR Partnership Regulatory Roundup meeting in Deadwood, South Dakota, on July 21–23, 2015.
- Worked on preparing budgets for this task.
- Continued planning for D8, Permitting Review – Update 2, due September 30, 2015, including checking the status of the North Dakota primacy application and changes to the Canadian and U.S. Environmental Protection Agency regulations.

Task 4 – Site Characterization and Modeling (James A. Sorensen)

Highlights

- **Bell Creek** test site activities included the following:
  - Held two half-day Petrel training sessions (June 23–24). This training was led by EERC staff and was attended by several other staff members and interns. A comprehensive workflow for creating a model and performing quality control on the data is being developed to assist with this work in the future.
  - Began planning for in-house training led by Baker Hughes for its JewelSuite software. This geologic modeling software may be used to supplement and support current modeling activities. Tentative dates for the training are July 28–31.
  - Summer graduate student interns have been preparing Bell Creek data for modeling.
  - Worked on adding data from the near-surface modeling into the reference model.
  - Worked on analyzing the structure in the Version 2 model. Uncertainty was discovered in select formation tops in the model. These tops are being adjusted as needed to create a more realistic structure for the Version 3 geologic model which, in turn, will lead to better simulation and history-matching results. This work will also improve the seismic processing and inversion and geomechanical modeling efforts.
  - Worked on assessing the formation tops in the geomechanical model for the Bell Creek Field, including the overburden and underburden formations. The location of these tops will affect the future geomechanical simulations.
  - Finalized the list of cores to view at the U.S. Geological Survey Core Research Center (CRC-Denver). Information gained from viewing the core will support the new understanding of the Bell Creek depositional model. Will likely schedule a trip to view these cores soon.
  - Continued working on creating synthetic DT logs from the pulsed-neutron logs (PNLs). These will be used to improve the seismic inversion process and geomechanical modeling efforts.
  - Participated in a conference call and Webinar for the DOE Site Characterization BPM working group. An updated list of best practices and comments on the report outline were provided to the group.

- Continued working on the numerical tuning process in Computer Modelling Group Ltd's (CMG's) GEM, specifically using the geomechanics function.
- Held the weekly modeling and simulation update meeting. All staff working on Bell Creek modeling and simulation discussed progress and collaborated to resolve any difficulties.
- Continued work on the PCOR Partnership Site Characterization BPM (D35).
- Continued reviewing the geomechanics module of COMSOL Multiphysics and investigating the application of this software to the Bell Creek geomechanical simulation work.
- Worked on renewing several modeling software licenses.
- Continued experiments on the mobilization of hydrocarbons in Bell Creek crude.
- Prepared an outline for the DOE Carbon Storage Systems and Well Management Systems BPM. It is currently undergoing internal review.
- Continued work on Applied Geology Laboratory activities, which included the following:
  - With regard to the 33-14R core (collected April 2013):
    - Continued work on the permeability-to-air report.
  - With regard to the 56-14R full-core plugs (collected March 2013):
    - An outline was prepared for the 56-14R core work final report.

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

- Downloaded new CO_2 pipeline test data from the Det Norske Veritas PIPETRANS site. The data are from tests performed on a highly instrumented, 1-km-long pipeline filled with CO_2 in which a hole was intentionally blown to determine 1) what happens during a pipeline rupture and 2) how CO_2 disperses from a large pipeline leak.
- Worked on updating the budget with respect to the budget period extension for this task.
- Responded to a question from a PCOR Partnership utility partner.
- Continued internal PCOR Partnership management review of a value-added report entitled "Assessing Temporary Storage Options to Manage Variable-Rate CO_2 Emissions for Use During Enhanced Oil Recovery." Following DOE review, the authors plan to submit the manuscript for possible publication in *Energy & Environmental Science*.

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)

Highlights

- Continued preparation of D49 (due August 31, 2015), the Bell Creek Test Site Transportation and Injection Operations Report.

Task 9 – Operational Monitoring and Modeling (Charles D. Gorecki)

Highlights

Bell Creek injection-phase site activities included the following:

- Attended the 2015 U.S. Rock Mechanics Geomechanics Symposium and Workshop in San Francisco, California, held June 27 – July 1, 2015.
- Attended and presented at the IEAGHG Monitoring Network Meeting in Berkeley, California, held June 10–12, 2015.
- Continued development of D66, the modeling and simulation report (due August 31, 2015). Held several progress meetings to discuss.
- Conducted a successful hard drive swap for the borehole geophone array on June 25. This process installed new hard drives for recording of passive seismic data.
- The GeoTomo MiVu software purchase was finalized. The software will be used for processing the microseismic data set collected at Bell Creek.
- Conducted a literature study for new methods to better simulate and analyze single-well performance. This information will be used to better understand performance of the wells and to update simulations.
- Worked on investigating COMSOL Multiphysics software for its application to simulating subsurface fluid flow for the Bell Creek project.
- Continued developing an outline and executive summary of the PCOR Partnership Monitoring, Verification, and Accounting (MVA) BPM.
- Continued the internal review process on M50, "Bell Creek Test Site – 2 years of Near-Surface Assurance Monitoring Completed," (due July 31, 2015).
- Continued working on M51 "Bell Creek Test Site – Initial Analysis for First Large-Scale Repeat Pulsed-Neutron Logging Campaign Post-Significant CO_2 Injection Completed," (due August 31, 2015).
- Continued to monitor the borehole seismic acquisition system via remote check-in and e-mail updates.
- Interns worked on producing a file of original well log images of the reservoir as part of the core-viewing trip being planned.
- A graduate student intern began assisting with Bell Creek simulation work, comparing the original and processed core and logging data with data in the simulation model. A difference in vertical permeability distribution was identified. The results will be used in updating the simulation model, analyzing single-well performance, and updating the Version 3 static model.
- A graduate student intern is currently working on processing the microseismic data collected at Bell Creek.
- Work on inversion of 3-D seismic data to derive geomechanical parameters for Bell Creek continues. Well ties and horizon picking are progressing.
- Several team members attended a Webinar hosted by CMG regarding numerical tuning during simulation. Numerical tuning is used to improve the simulation models to provide more accurate results.
- Finished checking core data and logs for all wells in Phase 1 and 2 areas. These data were compared with simulation model settings. Some differences were noted and will lead to further investigation, e.g., values for vertical permeability.

- Practiced using the CMOST numerical tuning function in CMG to improve simulation efficiency.
- Worked on updating the formation tops used in the simulation model and seismic data interpretation.
- Continued experiments to determine the effect of methane in CO_2 on Bell Creek crude oil MMP (minimum miscibility pressure).
- Continued data reduction on Bell Creek produced oil hydrocarbon molecular weight changes following CO_2 injection.
- Continued miscible-phase sampling of mobilized hydrocarbons using methane, CO_2, and ethane.
- Finished one continuous CO_2 injection and one water alternating gas predictive simulation case; the results will be included in the D66 report.
- The potential to host an in-house training for Linux administration is being investigated. The new geophysical processing workstation is Linux-based, and this training would increase efficiency in its operation.
- Worked with Core Labs in Houston, Texas, to get an update on the progress of the special core analysis (SCAL) work being conducted. The work is complete and will be reported on within the month.
- Submitted M49 "1.5 million metric tons of CO_2 Injected" (due June 30, 2015).
- Compiled and performed quality assurance/quality control checks on the most recent uncorrected publically available Bell Creek well production data (water, oil, and gas) through April 2015.
- With regard to the DOE BPMs:
  - Participated in the DOE MVA BPM 2016 revision editing committee call, and provided input on the draft outline. The PCOR Partnership took the lead in suggesting a combined approach for outline options by process or by formation to appeal to a wider audience, as well as adding a conclusion/summary section, both of which were accepted by the DOE RCSP team.
  - Participated in the June 3, 2015, conference call on the DOE Carbon Storage Systems and Well Management BPM. Finalized and submitted suggested changes to the outline.
  - Participated in the DOE Simulation and Risk Assessment BPM Webinar. Commented on the outline, and the updated document was uploaded to the EDX workspace.
- Used the most recent publicly available data to determine that cumulative CO_2 injection is 1,660,570 metric tons through November 30, 2014 (Table 1).
- Spoke with a representative of Denbury. They would like us to conduct some additional simulation scenarios. This work is ongoing.
- Continued injection-phase sampling work, including the following:
  - Conducted the quarterly Bell Creek MVA sample event (June 22–27, 2015).
    - Contacted all affected landowners ahead of the event.
  - Continued development of Bell Creek near-surface MVA sampling strategies for FY2016.
  - Activities completed from the sampling trip (April 24–30, 2015):
    - Completed review of the landowner packages (groundwater results).
    - Completed statistical processing of handheld meter and Quad Micro GC soil gas analyses from over 390 total samples including original samples, field blanks, and duplicates.

Table 1. Bell Creek CO_2 Injection Totals for November 2014 (cumulative totals May 2013 to November 2014)

	November 2014 Injection
Total, Mscf	3,046,040
Total, U.S. tons*	174,229
Total, metric tons*	158,211
Cumulative Total, Mscf [+]	31,970,963
Cumulative Total, U.S. tons*[+]	1,828,689
Cumulative Total, metric tons*[+]	1,660,570

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

* There has been a lag in posting of injection/production volumes to the MBOG database. This was calculated utilizing a conversion of 17.483 Mscf/U.S. ton and 19.253 Mscf/metric ton.

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

Task 10 – Site Closure (to be announced [TBA])

- This task is anticipated to be initiated in Quarter 1 – BP5, Year 9 (October 2015).

Task 11 – Postinjection Monitoring and Modeling (TBA)

- This task is anticipated to be initiated in Quarter 1 – BP5, Year 9 (October 2015).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Nothing to note at this time.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Traveled to Regina, Saskatchewan, to present at the Carbon Sequestration Leadership Forum (CSLF) Mid-Year Meeting, June 15–18, 2015.
- Hosted a Webinar on June 22, 2015, with the PCOR Partnership Technical Advisory Board (TAB) to discuss the transition of CO_2 EOR to CO_2 storage. The TAB provided a great deal of feedback regarding this issue and gave suggestions for areas needing further research. Potential journal article ideas were also discussed.
- Participated in a conference call with a representative of the U.S. Clean Air Task Force regarding the Climate Change Working Group platform. They are interested in having Bell Creek be a sister project to an EOR project in China.
- Reviewed and submitted abstracts to the DOE Carbon Storage R&D Program Review Meeting (six abstracts in total were submitted).
- Held a task leader meeting June 8, 2015. Topics discussed included the BP4 extension, including budgets and deliverables; upcoming conferences/meetings; and task leader updates.
- Worked on preparing budgets for the 6-month, $4.5M extension to BP4. Created a list of deliverables and milestones that will need to be adjusted because of the extension.

- Continued preparing for the PCOR Partnership Annual Membership Meeting. The evening event postcard was mailed, and registration is now live. Confirmation of presenters is ongoing.
- Spoke with a representative of Shell Canada (Shell) regarding his interest in presenting at the upcoming PCOR Partnership Annual Membership Meeting in September. He expressed interest in giving an overview of Shell's CCS activities. A formal invitation will follow.
- Continued investigating the specifications and costs of purchasing an additional node for the simulation cluster. This equipment would be used for PCOR Partnership simulation activities.
- Completed deliverables and milestones in June:
  - May monthly update
  - Task 2: D17 – General Phase III Information PowerPoint Presentation (Update 6)
  - Task 9: M49 – Bell Creek Test Site – 1.5 million metric tons of CO_2 Injected
  - Task 14: M23 – Monthly Water Working Group (WWG) Call Held

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

Highlights

- Held the monthly conference call on June 23, 2015. Discussed updates for the current WWG BPM and the WWG Annual Meeting.
- Distributed notes from the May 2015 call.
- Continued development of the WWG BPM (D80, due November 30, 2016) draft document with a consultant from CETER. We are working on having draft text prepared in time for the annual meeting.
  - The draft annotated outline was sent to Andrea McNemar for approval.
- Continued preparing for the WWG Annual Meeting to be held in August in Pittsburgh, Pennsylvania. A draft agenda has been developed. The meeting will focus on the development of the WWG BPM and its relation to the DOE BPMs being developed.
- Distributed the official announcement for the WWG Annual Meeting.
- Made revisions to an abstract for a poster to be presented at the DOE Carbon Storage R&D Program Review Meeting. The abstract focuses on the last fact sheet developed by the WWG on the subject of long-term protection of freshwater resources.
- On June 15, 2015, distributed the formal announcement of the Special Issue of the International Journal of Greenhouse Gas Control (IJGGC) on the "Nexus of Water and Carbon Capture and Storage" to the various stakeholders. These included the WWG, select members of the PCOR Partnership, select participants of the 12th International Conference on Greenhouse Gas Technologies (GHGT-12), and other researchers focused on water and CCS issues. Abstracts are due July 17, 2015.

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

- June 9–14, 2015: traveled to Berkeley, California, to present at the IEAGHG 10th Monitoring Network Meeting.
- June 11, 2015: traveled to Fargo, North Dakota, to meet with PPB education staff regarding the Teacher Training Institute.
- June 15–18, 2015: traveled to Regina, Saskatchewan, to present at the CSLF Mid-Year Meeting.
- June16, 2015: traveled to Bismarck, North Dakota, to present at the Lignite Energy Council teacher workshop.
- June 22–25, 2015: traveled to Meridian, Mississippi, to film locations and obtain interviews at Southern Company's Kemper County Energy Facility to use in the Coal and the Modern Age documentary.
- June 22–28, 2015: traveled to Gillette, Wyoming, for sampling at the Bell Creek site.
- June 23–24, 2015: traveled to Moorhead, Minnesota, to present at the Prairie Public Teacher Training Institute.
- June 26 – July 8, 2015: traveled to San Francisco, California, to attend the 2015 U.S. Rock Mechanics Geomechanics Symposium and Workshop.
- June 29 – July 1, 2015: traveled to White Salmon, Washington, to work as a technical advisor on the Coal and the Modern Age documentary.

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