Plains CO_2 Reduction (PCOR) Partnership Monthly Update
May 1–31, 2015

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Updated text for the Plains CO_2 Reduction (PCOR) Partnership Atlas (5th edition) due August 2015.
- Worked on modifications to the upcoming U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Atlas V.
- Attended and presented at the 14th Annual Carbon Capture, Utilization & Storage Conference (CCUS-14) in Pittsburgh, Pennsylvania, April 28 – May 1, 2015.
- Imported additional North Dakota LAS files into the Petra project.
- Continued database preventive maintenance of Petra projects.
- Added metadata to updated data sets.
- Updated information and continued work on the partners-only decision support system (DSS) Web site:
  - Updated carbon dioxide (CO_2) storage in saline formation tables.
  - Worked on data to be updated on the PCOR Partnership DSS partners-only and public Web sites.
  - Continued work on reformatting the Bell Creek-related information.
  - Continued collecting images from the last version of the PCOR Partnership Atlas to put in the image gallery.
  - Continued to assemble a presentation on the DSS online mapping services to showcase the capabilities for viewing results in a comprehensive and interactive framework.
  - Updated North Dakota and Montana Petra projects with the latest general well information from each state's online resource as follows: 126 new North Dakota wells and four new Montana wells.
  - Updated the North Dakota well injection information and production data and South Dakota, Saskatchewan, and Manitoba project information.
- Continued work on several value-added reports, including the following:
  - Finished the draft Inyan Kara Formation report. It is currently undergoing internal review.
  - Continued work on the report summarizing methods of original oil in place and CO_2 storage calculations.
  - Continued efforts on the Cedar Creek Anticline white paper.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:

- Traveled to Estevan, Saskatchewan, Canada, to attend and film the Aquistore ribbon-cutting ceremony.
- Continued to update the Aquistore simulation in an iterative fashion using injection data. These data are being received daily from the Petroleum Technology Research Centre (PTRC).
- Continued working with PTRC Science and Engineering Research Committee (SERC) regarding the Aquistore simulation model.
- Worked on log interpretation and analysis for the Aquistore site. The logs were compared to the simulation model results.

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

Highlights

- Continued efforts on an update to Deliverable 17 (D17), entitled "General Phase III Information PowerPoint," due May 31, 2015.
- Prepared a list of shots for use in producing examples of shots available for Aquistore to use in its outreach activities and provided Aquistore personnel with a sampler of video clips as a basis for determining clips for final production.
- Finalized updates for the Lignite Energy Council's (LEC's) teacher workshop presentation scheduled for June 16 in Bismarck, North Dakota, and provided LEC with the final version.
- Continued efforts to expand the type and presentation of statistics for overall past outreach activities and for planning.
- Initiated and finalized a PowerPoint and script for the presentation on the PCOR Partnership outreach activities presented at Session 7 at the 10th CO_2 GeoNet Open Forum, Venice, Italy, May 11–13, 2015.
- 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.
- Participated in the monthly Outreach Working Group call on May 21, 2015, that was focused on updating the outreach Best Practices Manual (BPM) and next steps. The Task 2 Team volunteered to take part in discussions related to developing an outreach metrics section of the BPM.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Moved forward on the current batch of Web page updates following internal review, provided comments on the programming done to date on the current batch of Web page updates, and gave approval, based on the review, to proceed to prepare a revised draft for review by Energy & Environmental Research Center (EERC) senior PCOR Partnership managers.
  - 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 graphic and interactive elements.
- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - Participated in a conference call to discuss travel plans for documentary D22 and finalized arrangements for upcoming location filming and interviews in New York City,

New Jersey, eastern Pennsylvania, Virginia, Mississippi, western Pennsylvania, and Washington during May and June.
  - PPB completed filming trips to New York City, New Jersey, eastern Pennsylvania, and Virginia for documentary D22.
  - Prepared questions for the interviews at the Kemper County Energy Facility in Mississippi for documentary D22.
  - PPB continued editing Parts 2, 3, and 4 of the four-part education video and prepared graphics on 1) global energy and population, 2) the overall concept of carbon reduction wedges, and 3) an explanation of how higher mile-per-gallon vehicles can lead to a carbon reduction wedge.
  - PPB prepared a sampler of shots for Aquistore available for use in its outreach activities.
  - PPB requested that Rely Media provide a transcription of a D22 interview as a basis for determining if Rely Media should be used to provide transcripts of all D22 interviews.

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

Highlights

- Continued planning the 2015 Regulatory Roundup scheduled for July 22–23, 2015, in Deadwood, South Dakota, including preparing a draft agenda and inviting potential speakers.
- Attended the IOGCC Annual Meeting in Salt Lake City, Utah, May 18–20, 2015.
- Presented at and facilitated the Interstate Oil and Gas Compact Commission (IOGCC) Environmental and Safety Committee meeting in Salt Lake City, Utah, May 19, 2015.
- Reviewed notes from IOGCC Environment and Safety Committee meeting.
- Reviewed U.S. Environmental Protection Agency (EPA) memorandum regarding Class II to Class VI transition, which was released April 23, 2015.
- Discussed potential PCOR Partnership value-added documents related to regulations.
- Continued planning for D8, Permitting Review – Update 2, due September 30, 2015, including checking the status of North Dakota primacy application and changes to the Canadian and EPA regulations.

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

Highlights

- **Bell Creek** test site activities included the following:
  - An in-house petrophysics and petrophysical modeling training was held at the EERC (May 27–28). PCOR Partnership partner Eric Pasternack of Outsource Petrophysics led the training, which included an overview of using PowerLog software. The knowledge gained in this training will be used to support the PCOR Partnership's Bell Creek modeling and simulation activities.
  - Investigating the potential to add properties from core-shifted logs into the 3-D Reference project.
  - Worked on exploring the potential to use pulsed-neutron logs (PNLs) to derive synthetic DT (sonic velocity) logs. These logs would be used to help improve the seismic inversion process and geomechanical modeling.

- Worked on cataloging and organizing the field and processed pulsed neutron and cement bond logs that have been collected at Bell Creek.
- Held wrap-up Webinar with Paulsson Inc. on May 18. Paulsson has been processing the repeat 3-D vertical seismic profiles and presented the results to the EERC staff during this Webinar.
- Worked on determining methods for using seismic data to contribute to more accurate geomechanical modeling. This included software and amplitude versus offset inversion. Several in-house meetings were held to discuss this.
- Continued preparing data and practicing for the geomechanical simulations within Petrel and Computer Modelling Group (CMG). Specifically, worked on improving data accuracy using the well logs and seismic data.
- Participated in conference call and Webinar for the DOE Site Characterization BPM working group. Worked on reviewing and commenting on the existing BPM and the proposed outline for the revision.
- Held two in-house presentations regarding the most recent PNL analysis. This work included 1) comparing the effective porosity and saturation values from the PNLs with the history-matched model's values and 2) using the PNLs to derive rock properties for layers above the reservoir. The current work has been completed; however, a plan is being created for the next steps of integrating the PNL and history-matched data sets to improve the geologic models. These analyses result in a more accurate model and better predictive simulations, leading to an improved understanding of reservoir performance for monitoring the injected CO_2.
- Continued working on the numerical tuning process in CMG GEM, specifically using the geomechanics functionality.
- Worked on planning proposed core-viewing activities for Bell Creek. This core viewing will support the development of the facies model by providing additional evidence for the current interpretation.
- Worked on creating a model of the Bell Creek injection zone using COMSOL modeling software. This could be used as initial input for any 2-D modeling conducted in COMSOL. COMSOL is being investigated as a means to provide additional support to the Bell Creek modeling and simulation activities.
- Renewed Hampson–Russell seismic processing software licenses. This software is donated by CGG to universities for research.
- Continued preparing the site characterization BPM (D35), due August 31, 2015.
- 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):
    - Continued preparing the final internal report for the permeability-to-air vs. permeability-to-water evaluation completed.

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

- Submitted D85 entitled "Opportunities and Challenges Associated with CO_2 Compression and Transport During CCS (carbon capture and storage) Activities."
- 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

- Performed literature searches and began preparation of D49, 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:

- Began planning for D66, the modeling and simulation report (due August 31, 2015). A preliminary outline was created.
- Participated in kickoff conference call for the DOE Carbon Storage Systems and Well Management Systems BPM.
  - Sent lessons learned based on PCOR Partnership experience related to the DOE Carbon Storage Systems and Well Management Activities BPM to the lead.
  - Reviewed and provided first-pass comments related to technical content of 2013 revision of BPM in preparation for a call on June 3, 2015.
- Compiled updated Montana Board of Oil and Gas (MBOG) oil, gas, and water production results from the online database for Bell Creek through December 2014.
- Investigated modifying the current Bell Creek monitoring, verification, and accounting (MVA) sample plan to address future phases of injection.
- Worked on acquiring GeoTomo microseismic processing software. This software will be used to process the passive seismic data being collected at Bell Creek.
- Participated in Webinars and conference calls for the DOE Simulation and Risk Assessment BPM. Will supply five best practice/case histories to the working group for discussion, along with comments on the document's overall outline.
- Successfully completed the history matching for CO_2 flooding for the combined Phase 1 and 2 model. This work included integrating CO_2 injection and fluid production data; comparing CO_2 flooding with primary depletion and water flooding; examining the geologic structure, permeability, water saturation, and relative permeability distributions in the combined region; and identifying ways to improve matching performance. The overall production and injection

profile in a subsection of the Phase 2 area of the combined model was successfully matched. This match included primary and secondary oil, water, and gas production; water injection; and analyzing production data of individual wells to identify possible aquifer and barrier locations in the reservoir. This information will help predict CO_2 plume distribution.

- Began work on M49 "1.5 Million Metric Tons of CO_2 Injected" (due June 30, 2015).
- Worked on preparing pressure maps at different dates. These will be used to help calculate saturation values at the same dates.
- Attended and presented at CCUS-14 in Pittsburgh, Pennsylvania, April 28 – May 1, 2015.
- Continued preparing for PCOR Partnership annual meeting workshop.
- Continued planning and preparation for the upcoming semiannual Bell Creek surface and near-surface sampling event (tentatively scheduled for the week of June 22, 2015) including organizing sampling kits; prepared a protocol (standard operating procedure) for prioritizing Bell Creek groundwater sample laboratory analyses based on field analytical results; and generated tables of recorded ranges for pH, alkalinity, and conductance at all groundwater sampling locations to aid the sampling crew in detecting any potential anomalies while in the field.
- A summer intern (graduate student from the University of Houston) started May 16, 2015, to help with Bell Creek simulation activities.
- Worked on checking the accuracy of the relative permeability curves used in the simulation model.
- Continued analyzing CO_2 injection and production in each well of the Bell Creek Field in an attempt to determine why certain wells have higher CO_2 production than others. This information will be useful for predictive simulations and history matching.
- Continued to develop alternate strategies for reduced monitoring, moving toward a commercially viable MVA strategy, specifically regarding frequency and focusing on key indicator analytes.
- Continued updating maps for coal, power plants, oil recovery, and CO_2 needed for fields in North Dakota and Montana.
- Continued analysis of processed permanent downhole monitoring data.
- 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).

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: 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.

- Continued database entry for tracking data drives for the borehole array and recording system.
- Continued injection-phase sampling work, including the following:
  - Completed the field (Micro Quad) gas chromatography (GC) analyses for the following produced gas analyses from three production wells:
    - 32-02 (sampled in March 2015)
    - 56-14 (sampled in March 2015)
    - 05-06 (sampled in January and March 2015)
  - Activities completed from the sampling trip (April 24–30, 2015):
    - Met with landowners and distributed packages from the September 2014 event.
    - Completed the EERC Analytical Research Laboratory and the selected Energy Laboratory water analyses from the following:
      - Residential well water samples = eight (8) project samples + (2) duplicate samples.
      - Stock well water samples = six (6) project samples.
      - Surface water samples = nine (9) project samples.
      - Fox Hills Formation groundwater-monitoring wells = two (2) project samples.
      - Initiated compiling landowner packages.
    - Completed processing the field analyses of fieldwide water sampling (26 sample locations total).
      - Statistical analyses (i.e., outlier tests, box plots, etc.) were completed based on all baseline field results by water type, as well as compared to operational monitoring results for possible outliers – no outliers of significance were observed.
    - Completed Micro Quad GC analyses on over 390 total bags for soil gas samples (including quality assurance/quality control samples such as blanks and duplicates).
      - Processing is under way.
    - Micro Quad and laboratory GC processing is completed for the purchase and recycled stream gas samples.
    - Micro Quad GC and laboratory GC analysis and processing are under way for the 32-02, 56-14, and 05-06 produced gas samples.
    - Processing is under way for the collected oil samples from Production Wells 05-06 and 32-02.

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)

<u>Highlights</u>

- Nothing to note at this time.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Attended and presented at the 10th Anniversary CO_2 GeoNet Open Forum in Venice, Italy, May 11–12, 2015. Three presentations were given: an overview of the PCOR Partnership, adaptive management approach, and outreach. Spoke with a representative from the Midwest Geological Sequestration Consortium (MGSC) at the forum regarding the potential to have a PCOR Partnership–MGSC collaborative technical meeting.
- Traveled to Estevan, Saskatchewan, Canada, to attend the Aquistore ribbon-cutting ceremony.
- Attended the IOGCC Annual Meeting in Salt Lake City, Utah, May 18–20, 2015.
- Spoke with a representative of 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 expanded storage for the data server, an additional node for the simulation cluster, and new modeling and simulation workstations. This equipment would be used for PCOR Partnership geologic modeling, seismic analysis, and simulation.
- Began planning a Webinar with the PCOR Partnership Technical Advisory Board (TAB) to discuss the transition of CO_2 enhanced oil recovery to CO_2 storage. This Webinar will likely be held in mid-June.
- Continued planning for the 2015 annual meeting to be held in Chicago, Illinois, in September. This included working on the draft meeting and workshop agendas. The evening event postcard will be mailed, and registration will be launched in early June.
- Submitted the purchase approval request to DOE for the new modeling and simulation workstations. This equipment would be used for PCOR Partnership geologic modeling, seismic analysis, and simulation. Approval for this purchase was received from DOE.
- Held a task leader meeting May 5, 2015. Topics discussed included brief updates on Bell Creek and Aquistore, upcoming conferences/meetings, and task leader updates.
- Attended and presented at CCUS-14 in Pittsburgh, Pennsylvania, April 28 – May 1, 2015.
- Completed deliverables and milestones in April:
  - April monthly update
  - Task 6: D85 – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities
  - Task 14: M23 – Monthly Water Working Group (WWG) Call Held

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

Highlights

- Held the monthly conference call on May 28, 2015. Discussed updates for the current WWG BPM and potential areas of overlap with current DOE BPM updates, discussed updates on a special journal of *International Journal of Greenhouse Gas Control* (IJGGC), and held a brief discussion regarding the WWG Annual Meeting.
- Distributed notes from the April 2015 call.
- Began developing a "Save the Date" notification for the WWG Annual Meeting. Official announcement will be distributed in June 2015.

- The call for papers for the Special Journal of IJGGC organized by PCOR should be distributed soon.
- Continued collaborative efforts with CETER, including the following:
  - Discussed last month's WWG conference call.
  - Distributed the April WWG conference call notes.
  - Distributed the latest update of the WWG BPM text to the group with a request for references appropriate to the discussion from the various partnership representatives.
  - Continued to make revisions to the draft WWG BPM (D80, due November 30, 2016).

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

- April 23 – May 1, 2015: traveled to Gillette, Wyoming, for Bell Creek project work.
- April 27–30, 2015: traveled to Regina, Saskatchewan, Canada, to attend the Williston Basin Petroleum Conference.
- April 27 – May 2, 2015: traveled to Pittsburgh, Pennsylvania, to present at CCUS-14.
- April 28 – May 1, 2015: traveled to Miles City, Montana, for Bell Creek site work.
- May 9–14, 2015: traveled to Venice, Italy, to present at the 10th CO_2 GeoNet Open Forum and Workshop.
- May 16–21, 2015: traveled to Salt Lake City, Utah, to attend the IOGCC Annual Meeting.
- May 28–29, 2015: traveled to Estevan, Saskatchewan, Canada, to attend and film the Aquistore project ribbon-cutting ceremony.

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