



Plains CO₂ Reduction (PCOR) Partnership Monthly Update September 1–30, 2015

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Attended the Plains CO₂ Reduction (PCOR) Partnership Annual Membership Meeting and Workshop in Chicago, Illinois, September 15–17, 2015.
- Submitted Deliverable (D)1, Review of Source Attributes (Update), on September 23, 2015.
- Continued compiling regional characterization data for the Mission Canyon Formation.
- Continued efforts to update D81, Regional Carbon Sequestration Atlas (update), due August 31, 2016, including tracking down oilfield shape files and data for Saskatchewan and Alberta.
- Updated information and continued work on the partners-only Decision Support System (DSS) Web site:
 - 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: 178 new North Dakota wells and seven new Montana wells were added.
 - Updated North Dakota and Manitoba monthly production information.
 - Updated North Dakota injection data.
 - Updated Manitoba, Saskatchewan, and South Dakota projects.
- With regard to the **Williston Basin** CO₂ Storage Sink Relative Permeability Laboratory Characterization:
 - Completed x-ray fluorescence (XRF) analyses.
 - Received thin sections and initiated petrographic analyses.
 - Completed Dean–Stark cleaning of hydrocarbons and salts from core plugs and dried to a constant mass in a humidified oven.
 - Completed bulk volume determination of the core plugs using a 3-D scanner.
 - Initiated porosity measurements.
 - Continued mercury injection capillary pressure (MICP) and x-ray diffraction (XRD) testing.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
 - Held a side meeting in conjunction with the PCOR Partnership Annual Membership Meeting. Discussed Aquistore injectivity with representatives from Petroleum Technology Research Centre (PTRC).

- Continued to update database with daily injection data from PTRC.
- Continued updating the simulation model. Used Computer Modelling Group (CMG) software to run simulations.
- Began compiling daily SaskPower data into one database.
- Began investigating potential options (e.g., stimulation) to increase injectivity.
- Worked on simulation draft report.
- Gained access to the baseline 3-D seismic data to be incorporated in modeling efforts, and began preliminary geologic interpretation for the Winnipeg Group and Deadwood Formation.
- Continued work on comparing properties in the static model with the history-matched simulation model properties. The purpose is to compare the two models to ensure changes made to achieve a history match make sense with known geologic data.

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

Highlights

- Attended the PCOR Partnership Annual Membership Meeting and Workshop in Chicago, Illinois, September 15–17, 2015. Discussed potential interviews and location filming for Documentary D22.
- Continued work on the draft Phase II project fact sheets. The Energy & Environmental Research Center (EERC) PCOR Partnership managers continued final review of the updated Phase II Northwest McGregor and Lignite fact sheets.
- Continued discussions with PTRC regarding collaboration on a paper and presentation at the Greenhouse Gas Control Technologies (GHGT)-13 Conference to be held November 14–18, 2016.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
 - Finalized several sections of the PCOR Partnership public Web site updates and continued preparation of key pages for topical reports and technical posters.
 - Compiled background and contact information on educators and other groups in the region to aid PCOR Partnership Web development and tracking.
 - Began working on potential content for the next round of updates for the public PCOR Partnership Web site.
 - Continued ongoing identification and repair of broken links.
- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
 - Reviewed transcripts of interviews and completed an initial draft of the script using materials from the master file of interview transcripts for Documentary D22.
 - Obtained permission for an interview and location filming at the Dakota Gasification Company facility in North Dakota for use in the D22 documentary, and efforts continued to schedule other interviews and location shoots for Documentary D22.
 - Interviewed Science Director, Maggie Koerth-Baker, in Minneapolis, Minnesota, for the D22 documentary.
 - Submitted final edits for the Meeting the Challenge education presentation video Parts 3 and 4

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

Highlights

- Attended the Interstate Oil and Gas Compact Commission (IOGCC) Annual Meeting in Oklahoma City, Oklahoma, September 28–30, 2015.
- Continued gathering information for value-added report on rules, regulations, and statutes for various scenarios of carbon capture and storage (CCS) geologic storage and for CO₂ enhanced oil recovery (EOR) for each of the PCOR Partnership states and provinces. Searched Partnership states and provinces for contact information for oil and natural gas and carbon capture, use, and storage regulators.
- Discussed regulatory issues with representatives from Alberta Energy, Saskatchewan Ministry of the Economy, and Tundra Oil and Gas Partnership at the PCOR Partnership Annual Membership Meeting.
- Submitted D8, Permitting Review – Update 2, on September 30, 2015.
- Continued work on preparing descriptor language and flowcharts of North Dakota injection well permitting requirements.

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

Highlights

- **Bell Creek** test site activities included the following:
 - Attended and presented a poster entitled “Multiscale Reservoir Modeling for CO₂ Storage and Enhanced Oil Recovery Using Multiple-Point Statistics” at the 2015 European Association of Geoscientists and Engineers (EAGE) Petroleum Geostatistics conference in Biarritz, France, September 7–11, 2015.
 - Attended the PCOR Partnership Annual Membership Annual Meeting and Workshop in Chicago, Illinois, September 15–17, 2015.
 - Attended a COMSOL software workshop in Grand Forks, North Dakota, to determine potential application of this software to the Bell Creek geomechanical simulations.
 - Continued work on the PCOR Partnership site characterization best practices manual (BPM) (D35).
 - Continued working on the construction of regional and basin-scale Bell Creek Muddy Formation models.
 - Continued work on geomechanical modeling, including the following:
 - ♦ Used Petrel to improve the geologic properties of the 3-D MEM using data from the 3-D seismic inversion.
 - ♦ Used CMG software to run simulations.
 - ♦ Continued preparing for the geomechanical simulation work using GEM and FLAC3D software.
 - ♦ Continued updating the rock mechanical properties, including Young’s modulus, Poisson’s Ratio, rock strength, and in situ stresses, for 1-D and 3-D MEM based on well and seismic data, well logs, pulsed-neutron logs (PNLs), lab data, and 3-D seismic data.
 - ♦ Continued seismic horizon interpretation in the reprocessed baseline 3-D and repeat 4-D seismic surveys and linking the Hampson–Russell outputs with the geologic modeling software (Petrel).

- ◆ Updated shapefiles and database files and added metadata.
- ◆ Worked on comparing PNL data to history-match results. Used curve interpolation to quantify the variation between PNLs and history-match fluid saturation and porosity.

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 PCOR Partnership Annual Membership Annual Meeting and Workshop in Chicago, Illinois, September 15–17, 2015.
- Attended the IEAGHG Third Post-Combustion Capture Conference (PCCC3) held in Regina, Saskatchewan, Canada, September 8–9, 2015.
- Continued internal PCOR Partnership management review of a value-added report entitled “Assessing Temporary Storage Options to Manage Variable-Rate CO₂ Emissions for Use During Enhanced Oil Recovery.” Following U.S. Department of Energy (DOE) review, the authors plan to submit the manuscript for possible publication in *Energy & Environmental Science*.
- Answered questions regarding the Dresser–Rand supercompressor and CO₂ capture costs for a PCOR Partnership partner.

Task 7 – CO₂ 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

- Submitted D49, Bell Creek Test Site Transportation and Injection Operations Report, on September 29, 2015.

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

Highlights

- Attended the CO₂ and Monitoring, Verification, and Accounting Workshop in Oslo, Norway, September 4–7, 2015.
- Attended the PCOR Partnership Annual Membership Meeting and Workshop in Chicago, Illinois, September 15–17, 2015.
- Traveled to Plano, Texas, September 24–25, 2015, to meet with Denbury personnel. Presented on the EERC’s Bell Creek activities.
- Attended the North Dakota GIS User Conference in Fargo, North Dakota, September 28–29, 2015.
- Attended Petrel Fundamentals Training in Houston, Texas, September 28–29, 2015.

- A PCOR Partnership consultant attended the International Energy Agency Greenhouse Gas (IEAGHG) Risk Management & Environmental Research Combined Networks Meeting in Southampton, United Kingdom, September 29 – October 1, 2015.
- Continued work on a draft of the PCOR Partnership monitoring, verification, and accounting (MVA) BPM.
- **Bell Creek** injection-phase site activities included the following:
 - Received authorization from Denbury to proceed with the 17-well expanded fall 2015 PNL campaign as proposed. Logging is anticipated to commence late October.
 - Received new MOREVision unit to install in Bell Creek permanent downhole monitoring (PDM) system.
 - Passive seismic observation GeoRes computer was completely shut down (first occurrence). Successfully rebooted the system via remote power controls. Continued to monitor the system. New drives were installed.
 - Continued data evaluation from experimentation of mobilized hydrocarbons using methane, CO₂, and ethane at Bell Creek reservoir conditions.
 - Started mixing methane–CO₂ ratios to fill in the gaps in the related minimum miscibility pressure (MMP) experiments.
 - Added metadata to missing files and archived old data.
 - Worked on analyzing 3-D seismic data, including creating difference maps and preparing for joint 4-D inversion using the baseline and monitoring datasets.
 - Continued 4-D seismic analysis.
 - Processed PDM data through June 2015.
 - Worked on individual well log and core data comparison in Phase 1 and 2 areas for the Version 3 geologic model update.
 - Continued efforts to develop a Bell Creek Phase 3–7 simulation model to begin the history-matching process, including processing the Phase 3 and 4 production/injection data.
 - Used the most recent publicly available data to determine that cumulative total CO₂ gas injection is 2,539,042 metric tons through April 30, 2015. Note that this value includes the combined purchased and recycled gas streams for total volume injected and is not corrected for gas composition of approximately 96% CO₂ (Table 1).
 - New methodology has been implemented to provide DOE with cumulative total gas purchase volumes for injection (not corrected for gas composition) and estimated associated CO₂ storage volumes (corrected for gas composition) in addition to total gas injection volumes. Custody transfer meter data supplied by Denbury provides monthly total gas purchase volumes, which are then corrected using gas compositional data. As of July 31, 2015, the most recent month of record, 2.383 million tonnes of total gas (composition of approximately 96% CO₂) has been purchased for injection into the Bell Creek Field, equating to an estimated 2.301 million tonnes of CO₂ stored (Table 2).
 - Continued injection-phase sampling work, including the following:
 - ♦ Analyzed purchase, recycle, and produced gas Summa canisters.
 - ♦ Traveled to Gillette, Wyoming, for near-surface sampling at the Bell Creek site, August 23 – September 1, 2015.
 - ♦ Activities completed from the annual full-field event (August 24–28, 2015):
 - Collected approximately 350 soil gas bags, performed analyses, and initiated review of preliminary soil gas results from the samples.

Table 1. Bell Creek CO₂ Gas Injection Totals for April 2015 (cumulative totals May 2013 to April 2015)*

	April 2015 Injection
Total, Mscf	3,280,561
Total, U.S. tons [†]	187,643
Total, metric tons [†]	170,392
Cumulative Total, Mscf [‡]	48,884,167
Cumulative Total, U.S. tons ^{†‡}	2,796,097
Cumulative Total, metric tons ^{†‡}	2,539,042

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

* 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.

[†] 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.

Table 2. Cumulative Total Gas Purchased and Estimated Associated CO₂ Storage Volumes for the Bell Creek Field¹

	July 2015 Gas Volume
Monthly Total Gas Purchased, MMscf ²	1928
Monthly Total Gas Purchased, million tons ²	0.110
Monthly Total Gas Purchased, million tonnes ²	0.100
Cumulative Total Gas Purchased, MMscf ^{2,3}	45,876
Cumulative Total Gas Purchased, million tons ^{2,3}	2.624
Cumulative Total Gas Purchased, million tonnes ^{2,3}	2.383
Cumulative Total CO ₂ Stored, MMscf ^{3,4}	44,299
Cumulative Total CO ₂ Stored, million tons ^{3,4}	2.534
Cumulative Total CO ₂ Stored, million tonnes ^{3,4}	2.301

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 CO₂ stored volumes are **CORRECTED** for gas composition.

- Collected and analyzed 19 groundwater samples and reviewed the water chemistry data.
- Reviewed landowner results (groundwater) letters and cover pages.
- Worked with landowners to schedule revisits to collect groundwater parameter readings.

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

- This task is anticipated to be initiated in Quarter 1 – BP 5, Year 9 (April 2016).

Task 11 – Postinjection Monitoring and Modeling (TBA)

- This task is anticipated to be initiated in Quarter 1 – BP5, Year 9 (April 2016).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Nothing to note at this time.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Hosted and presented at the PCOR Partnership Annual Membership Meeting and Workshop in Chicago, Illinois, September 15–17, 2015. Also held Aquistore project and Technical Advisory Board (TAB) side meetings.
- Attended the North Dakota Petroleum Council (NDPC) Annual Meeting in Fargo, North Dakota, September 21–23, 2015.
- Met with Denbury personnel for presentation on the EERC’s Bell Creek activities in Plano, Texas, September 24–25, 2015.
- Attended the IOGCC Annual Meeting in Oklahoma City, Oklahoma, September 28–30, 2015.
- At DOE’s request, submitted a memo for injection volume at Bell Creek.
- At DOE’s request, submitted a response regarding fiscal year (FY)16 DOE tracked milestones, one a quarter. Submitted revised milestone M58 title to DOE upon request following discussion with DOE representatives.
- Received award for PCOR Partnership Budget Period (BP) 4 extension (September 25, 2015). Working on revising the project management plan accordingly.
- Met with task leaders to discuss how PCOR Partnership might be involved with beta testing various National Risk Assessment Partnership (NRAP) tools.
- Held a task leader meeting September 1, 2015. Topics discussed included the preparations for the PCOR Partnership annual meeting, brief updates on Bell Creek and Aquistore, upcoming conferences/meetings, and task leader updates.
- Completed deliverables and milestones in September:
 - August monthly update
 - Task 1: D1 – Review of Source Attributes (update)
 - Task 3: D8 – Permitting Review (Update 2)
 - Task 8: D49 – Bell Creek Test Site – Transportation and Injection Operations Report
 - Task 14: M23 – Monthly WWG Conference Call Held

Task 14 – Regional Carbon Sequestration Partnership (RCSP) Water Working Group (WWG) Coordination (Ryan J. Klapperich)

Highlights

- Attended the PCOR Partnership Annual Membership Meeting and Workshop in Chicago, Illinois, September 15–17, 2015.
- Contacted contributors to the special issue of *International Journal of Greenhouse Gas Control* (IJGGC) on the “Nexus of Water and Carbon Capture and Storage.”

- Continued development of draft paper for the special journal issue of IJGGC on behalf of the WWG.
- Held the monthly conference call on September 30, 2015. Discussed the outcomes of the annual meeting and path forward. Discussed the time lines of DOE's BPMs and how additional items would be designed and added.
- Continued review of DOE BPMs for inclusion of water-focused material. Prepared one-page draft/example document for the Site Characterization BPM. Discussed potential ideas with a consultant from CETER.
- Sent updates for WWG Web site to KeyLogic Systems.

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO₂ 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 23 – September 1, 2015: traveled to Gillette, Wyoming, for sampling at the Bell Creek site.
- September 4–7, 2015: traveled to Oslo, Norway, to present at the CO₂ and Monitoring, Verification, and Accounting Workshop.
- September 4–12, 2015: traveled to Biarritz, France, to present at the EAGE Petroleum Geostatistics Conference.
- September 7–11, 2015: traveled to Regina, Saskatchewan, Canada, to attend the IEAGHG 3rd Post-Combustion Capture Conference.
- September 12–17, 2015: traveled to Chicago, Illinois, to host and present at the PCOR Partnership Annual Membership Meeting, the CO₂ EOR Workshop, the TAB Meeting, and an Aquistore project update meeting.
- September 21–23, 2015: traveled to Fargo, North Dakota, to attend the NDPC Annual Meeting.
- September 24–25, 2015: traveled to Plano, Texas, to attend meetings with and present to Denbury.
- September 26–27, 2015: traveled to Houston, Texas, to attend Next Training with Schlumberger.
- September 26 – October 1, 2015: traveled to Oklahoma City, Oklahoma, to attend the IOGCC Annual Meeting.
- September 27 – October 1, 2015: traveled to Southampton, United Kingdom, to present at the IEAGHG Risk Management & Environmental Research Combined Network Meetings.
- September 28–29, 2015: traveled to Houston, Texas, to attend Petrel Fundamentals training.
- September 28–29, 2015: traveled to Fargo, North Dakota, to attend the GIS Users Conference.

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