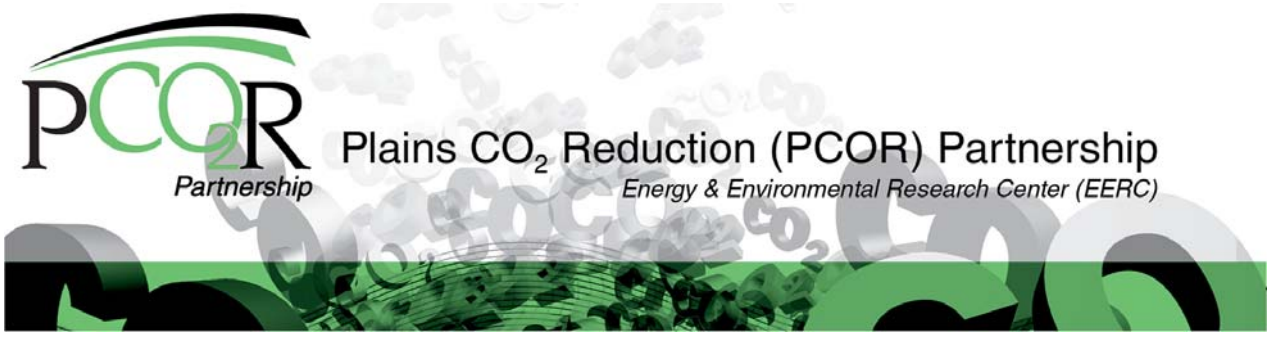

ANNUAL ASSESSMENT REPORT

Plains CO_2 Reduction (PCOR) Partnership Phase III
Task 12 – Deliverable D57

(for the period October 1, 2011, through September 30, 2012)

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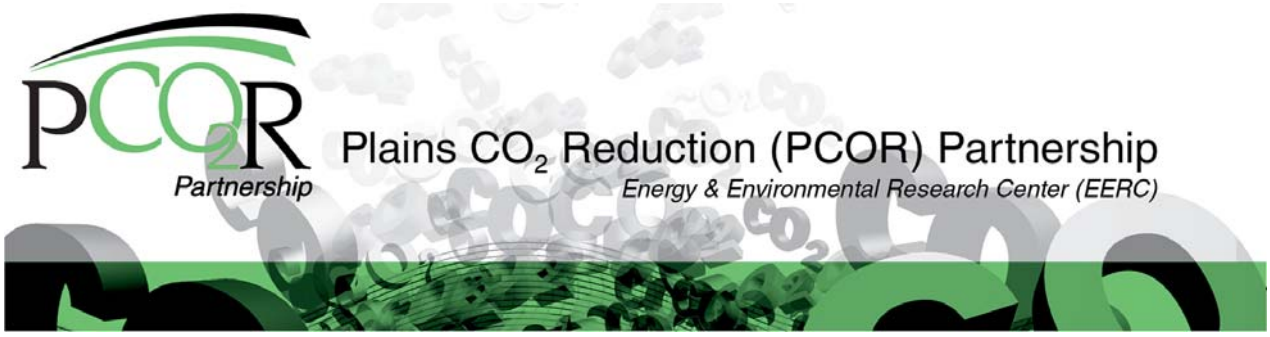


ANNUAL ASSESSMENT REPORT

EXECUTIVE SUMMARY

The Plains CO_2 Reduction (PCOR) Partnership is one of seven Regional Carbon Sequestration Partnerships (RCSPs) competitively awarded by the U.S. Department of Energy National Energy Technology Laboratory in 2003 as part of a national plan to mitigate greenhouse gas emissions. The PCOR Partnership is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota in Grand Forks, North Dakota, and includes over 90 stakeholders from the public and private sector in Phase III. The PCOR Partnership region includes all or part of nine U.S. states and four Canadian provinces.

Phase III, the 10-year (2007–2017) development phase, is an extension of the characterization (Phase I) and validation (Phase II) phases and is intended to confirm that carbon dioxide (CO_2) capture, transportation, injection, and storage can be achieved safely, permanently, and economically over extended periods in the PCOR Partnership region.

The Phase III efforts of the PCOR Partnership include two large-volume demonstration tests that focus on injecting CO_2 into deep geologic formations for CO_2 storage. The Fort Nelson demonstration involves monitoring, verification, and accounting (MVA) and risk management support for the injection of CO_2 captured from one of the largest gas-processing plants in North America into a saline formation in British Columbia, Canada. The Bell Creek demonstration involves injection of CO_2 into the sandstone of the Muddy Formation in the Powder River Basin in Southeastern Montana for the dual purpose of CO_2 storage and enhanced oil recovery. Other activities in Phase III include the following: 1) continue to gather regional characterization data to verify the ability of target formations to store CO_2, 2) facilitate the development of infrastructure to transport CO_2 from sources to injection sites, 3) facilitate sensible development of the rapidly evolving North American regulatory and permitting framework, 4) develop opportunities for PCOR Partnership partners to capture and store CO_2, 5) facilitate establishment of a technical framework by which carbon credits can be monetized for CO_2 stored in geologic formations, 6) continue collaboration with other RCSPs, and 7) provide outreach and education for CO_2 capture and storage stakeholders and the general public.

Significant progress occurred in Program Year (PY) 5 (October 1, 2011 – September 30, 2012) on the Bell Creek demonstration project. Efforts were largely focused on the Bell Creek MVA program, which includes both surface and near-surface MVA activities and deep MVA activities. Four field sampling events were held to establish preinjection surface water, groundwater, and soil gas baseline conditions. A deep monitoring well, 0506OW, was drilled

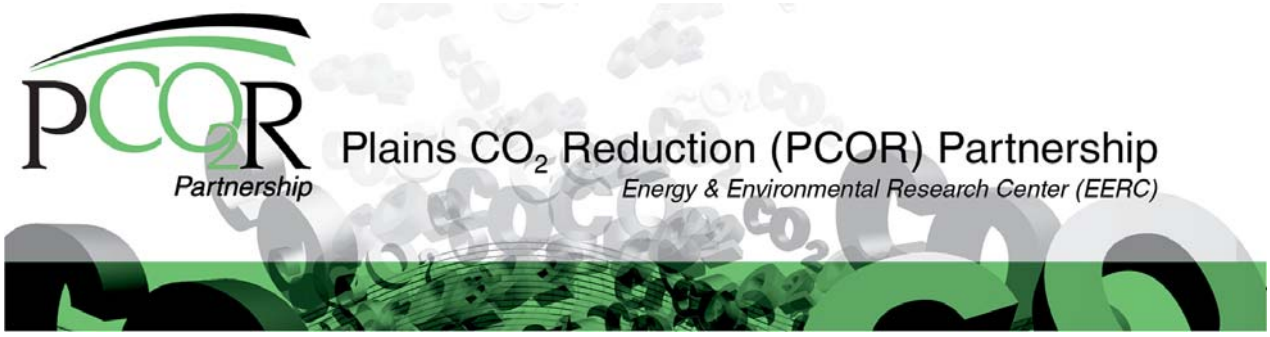
and completed in December 2011 in the Phase 1 area of the Bell Creek Field. Significant wellbore integrity data was collected, and petrophysical evaluations on collected core were performed.

Activities for the Fort Nelson demonstration project included further site characterization and geochemical observations. Significant updates were made to the static geologic model, and dynamic simulation evaluations continued.

Activities that will lead to the initiation of CO_2 injection in both demonstration sites will continue during PY6 (2012–2013), while initiation of CO_2 injection is anticipated in the first quarter of calendar year 2013 at the Bell Creek location. Operational monitoring and modeling activities will continue to be performed to verify that injection operations do not adversely impact human health or the environment and that the CO_2 injected has been safely stored, with minimal risk of natural release. All other support tasks will also continue to be implemented.

All other tasks also continued to effectively support program goals. Regional characterization continues, and the Rival oil field was identified as a candidate for tertiary CO_2 EOR activities and CO_2 storage. The *PCOR Partnership Atlas, 4th Edition*, was printed in June 2012. Outreach activities included distribution of print materials, oral presentations, Web site updates, and documentary broadcasts. In collaboration with Prairie Public Broadcasting (PPB), over 27 hours of film was captured for use in the upcoming Bell Creek demonstration documentary. Over 5 hours of raw film footage was captured by PPB during a spring 2012 trip to the Fort Nelson area. The Fourth Annual Regulatory Roundup was held in summer 2012, and the PCOR Partnership is leading a task force with IOGCC to address operational and postoperational liability issues. The RCSP Water Working Group was active and held its fourth annual meeting in May 2012. Additional data are being collected to conduct modeling on pinnacles in the Zama oil field, and the geological characterization of the basal Cambrian system is well under way.

This report presents an update of Phase III PCOR Partnership activities from October 1, 2011, through September 30, 2012 (PY5), and planned activities for the following year.



ANNUAL ASSESSMENT REPORT

INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership is one of seven regional partnerships operating under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Carbon Sequestration Partnership (RCSP) Program. The PCOR Partnership is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota (UND) in Grand Forks, North Dakota, and includes over 90 stakeholders from the public and private sector in Phase III. The Phase III membership as of September 30, 2012, is listed in Table 1. The PCOR Partnership region includes all or part of nine states (Iowa, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming) and four Canadian provinces (Alberta, British Columbia, Manitoba, and Saskatchewan).

The PCOR Partnership falls within the infrastructure element of NETL's Carbon Storage Program and is a government–industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture, utilization, and storage (CCUS) on the North American continent.

The PCOR Partnership Program is being implemented in three phases:

- Phase I – Characterization Phase (2003–2005): characterized opportunities for carbon sequestration.
- Phase II – Validation Phase (2005–2009): conducted small-scale field validation tests.
- Phase III – Development Phase (2007–2017): conducting large-volume carbon storage demonstration tests.

The PCOR Partnership's efforts are in support of NETL's Carbon Storage Program by helping to develop technologies to store carbon dioxide (CO_2) in order to reduce greenhouse gas (GHG) emissions without adversely influencing energy use or hindering economic growth.

The PCOR Partnership's efforts will help enable technologies to overcome a multitude of economic, social, and technical challenges, including cost-effective CO_2 capture through successful integration with fossil fuel conversion systems, effective CO_2 monitoring and verification, permanence of underground CO_2 storage, and public acceptance.

Table 1. PCOR Partnership Membership Phase III (October 1, 2007 – present, inclusive)

DOE NETL	Great Northern Project Development, LP	North Dakota Industrial Commission Oil and Gas Research Council
UND EERC	Great River Energy	North Dakota Natural Resources Trust
Abengoa Bioenergy New Technologies	Halliburton	North Dakota Petroleum Council
Air Products and Chemicals	Hess Corporation	North Dakota Pipeline Authority
Alberta Department of Energy	Huntsman Corporation	Otter Tail Power Company
Alberta Department of Environment	Husky Energy Inc.	Oxand Risk & Project Management Solutions
Alberta Innovates – Technology Futures	Interstate Oil and Gas Compact Commission	Petroleum Technology Research Centre
ALLETE	Indian Land Tenure Foundation	Petroleum Technology Transfer Council
Ameren Corporation	Iowa Department of Natural Resources	Pinnacle, a Halliburton Service
American Coalition for Clean Coal Electricity	Lignite Energy Council	Prairie Public Broadcasting
American Lignite Energy	Manitoba Geological Survey	Pratt & Whitney Rocketdyne, Inc.
Apache Canada Ltd.	Marathon Oil Company	Praxair Inc.
Aquistore	MEG Energy Corporation	Ramgen Power Systems, Inc.
Baker Hughes Incorporated	Melzer Consulting	RPS Energy Canada Ltd.
Basin Electric Power Cooperative	Minnesota Power	Saskatchewan Ministry of Industry and Resources
BillyJack Consulting Inc.	Minnkota Power Cooperative, Inc.	SaskPower
Biorecro AB	Missouri Department of Natural Resources	Schlumberger
Blue Source, LLC	Missouri River Energy Services	Shell Canada Energy
BNI Coal, Ltd.	Montana–Dakota Utilities Co.	Spectra Energy
British Columbia Ministry of Energy, Mines, and Petroleum Resources	Montana Department of Environmental Quality	Suncor Energy Inc.
British Columbia Oil and Gas Commission	National Commission on Energy Policy	TAQA North, Ltd.
C12 Energy, Inc.	Natural Resources Canada	TGS Geological Products and Services
Computer Modelling Group Ltd.	Nebraska Public Power District	University of Alberta
Dakota Gasification Company	North American Coal Corporation	University of Regina
Denbury Onshore LLC	North Dakota Department of Commerce Division of Community Services	Weatherford Advanced Geotechnology
Eagle Operating, Inc.	North Dakota Department of Health	Western Governors' Association
Eastern Iowa Community College District	North Dakota Geological Survey	Westmoreland Coal Company
Enbridge Inc.	North Dakota Industrial Commission Department of Mineral Resources, Oil and Gas Division	Williston Basin Interstate Pipeline Company
Encore Acquisition Company	North Dakota Industrial Commission Lignite Research, Development and Marketing Program	Wisconsin Department of Agriculture, Trade and Consumer Protection
Energy Resources Conservation Board/ Alberta Geological Survey		Wyoming Office of State Lands and Investments
Environment Canada		Xcel Energy
Excelsior Energy Inc.		

The PCOR Partnership was established in the fall of 2003. Phase I was focused on characterizing sequestration opportunities in the region. In the fall of 2005, the PCOR Partnership launched its 4-year Phase II program focused on carbon storage field validation projects. These Phase II projects were designed to build core local technical expertise and experience needed to facilitate future large-scale CO_2 storage efforts in the region's subsurface and terrestrial settings. In the fall of 2007, the PCOR Partnership initiated its 10-year Phase III program focused on implementing two commercial-scale geologic carbon storage demonstration projects in the region.

Phase III is divided into three budget periods (BPs), running from October 1, 2007, to September 30, 2017:

BP3: October 1, 2007 – September 30, 2009
BP4: October 1, 2009 – September 30, 2015
BP5: October 1, 2015 – September 30, 2017
Note: BP1 and BP2 were effective in Phase II.

The overall mission of the Phase III program is to 1) gather characterization data to verify the ability of the target formations to store CO_2, 2) facilitate the development of the infrastructure required to transport CO_2 from sources to the injection sites, 3) facilitate development of the rapidly evolving North American regulatory and permitting framework, 4) develop opportunities for PCOR Partnership partners to capture and store CO_2, 5) establish a technical framework by which carbon credits can be monetized for CO_2 stored in geologic formations, 6) continue collaboration with other RCSPs, and 7) provide outreach and education for CO_2 capture and storage stakeholders and the general public.

In Phase III, the PCOR Partnership is building on the information generated in its characterization (Phase I) and validation (Phase II) phases. The PCOR Partnership plans to fully utilize the infrastructure of its region to maximize CO_2 injection volumes. A programmatic development phase (Phase III) goal is implementation of large-scale field testing involving at least 1 million tons (Mt) of CO_2 per project. Each of the RCSP's large-volume injection tests is designed to demonstrate that the CO_2 storage sites have the potential to store regional CO_2 emissions safely, permanently, and economically for hundreds of years.

The PCOR Partnership is working toward the establishment of two demonstration sites. The sites are located 1) in Denbury Resources Inc. (Denbury's) Bell Creek oil field in Powder River County, southeastern Montana, and 2) near Spectra Energy's (Spectra's) Fort Nelson gas-processing facility, situated near Fort Nelson, British Columbia, Canada (Figure 1).

Figure 1. PCOR Partnership Phase III demonstration sites.

In Program Year (PY) 5, at the Bell Creek test site, efforts were largely focused on developing the Bell Creek MVA program plan and collecting baseline MVA data. Four field sampling events were held to collect preinjection surface water, groundwater, and soil gas baseline data. In addition, a deep monitoring well, 0506OW, was spud in December 2011 in the Phase 1 area of the Bell Creek Field. A significant volume of wellbore integrity data was collected, and petrophysical evaluations on collected core were performed.

In collaboration with Spectra, the PCOR Partnership is pursuing a large-scale integrated carbon capture and storage (CCS) project near Spectra's existing Fort Nelson natural gas-processing facility in northeast British Columbia, Canada. The Fort Nelson facility is one of the largest sour gas-processing plants in North America. This plant processes gas from an extensive network of approximately 620 miles of gathering pipelines servicing the Horn River producing basin. The sour CO_2 (approximately 95% CO_2 and 5% hydrogen sulfide [H_2S]) developed by this process will be pipelined a short distance to a storage site. The PCOR Partnership's MVA efforts will help Spectra determine whether deep underground saline reservoirs and associated infrastructure in the Fort Nelson area are appropriate for CCS.

During PY5, activities for the Fort Nelson demonstration project included further site characterization and geochemical observations. Significant updates were made to the static geologic model, and dynamic simulation evaluations continued. Unfortunately, Spectra's plans for winter 2011–2012 drilling activities were shelved, resulting in delays to CO_2 injection plans.

The PCOR Partnership's objectives for the demonstration projects are as follows: 1) conduct a successful Bell Creek demonstration to verify that the region's large number of oil fields have the potential to store significant quantities of CO_2 in a safe, economical, and environmentally responsible manner and 2) conduct a successful Fort Nelson demonstration to verify the economic feasibility of using the region's carbonate saline formations for safe, long-term CO_2 storage. During Phase III, the PCOR Partnership will continue to refine storage resource estimates and evaluate other factors relevant to regional storage goals.

APPROACH

The PCOR Partnership is identifying practical CO_2 storage options for the PCOR Partnership region, characterizing the technical issues, enhancing the public's understanding of CO_2 storage, identifying the most promising opportunities for storage in the region, and detailing an action plan for the demonstration of regional CO_2 storage opportunities.

The PCOR Partnership is achieving its Phase III mission through a series of 16 tasks, as shown in Figure 2. These tasks include 1) Regional Characterization; 2) Public Outreach and Education; 3) Permitting and National Environmental Policy Act (NEPA) Compliance; 4) Site Characterization and Modeling; 5) Well Drilling and Completion; 6) Infrastructure Development; 7) CO_2 Procurement; 8) Transportation and Injection Operations; 9) Operational Monitoring and Modeling; 10) Site Closure; 11) Postinjection Monitoring and Modeling; 12) Project Assessment; 13) Project Management; 14) RCSP Water Working Group (WWG) Coordination; 15) Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and

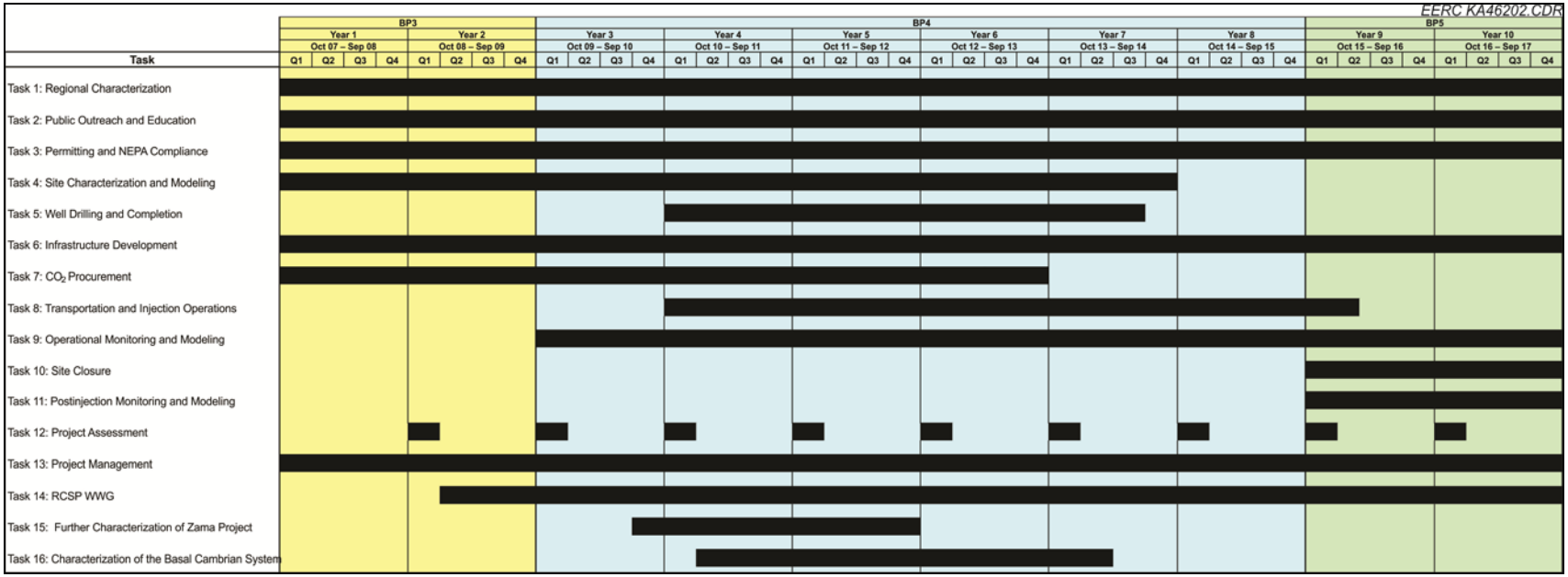


Figure 2. Phase III tasks.

Monitoring Project; and 16) Characterization of the Basal Cambrian System. Table 2 contains the responsibility matrix of these 16 tasks.

The EERC entered into a cooperative agreement with DOE NETL for Phase III activities in late September 2007. Phase III is a 10-year project, in three BPs, running from October 1, 2007, to September 30, 2017. This Annual Assessment Report summarizes the activities for PY5 (October 1, 2011 – September 30, 2012) for Phase III.

ASSESSMENT SUMMARY

In BP3, the focus of the program was to select two regionally significant, yet different, geologic formations for large-volume (approximately 1 Mt of CO_2 a year) commercial tests designed to demonstrate that CO_2 storage sites have the potential to store regional CO_2 emissions safely, permanently, and economically for hundreds of years. The Fort Nelson test site was selected in December 2007 and involves MVA support for the injection of up to 2 Mt/year CO_2 captured from one of the largest gas-processing plants in North America into a Devonian-aged carbonate formation in British Columbia, Canada. The Bell Creek test site was selected in September 2009 and involves injection of CO_2 into a Cretaceous-aged sandstone formation in the Powder River Basin (PRB) in southeastern Montana for the dual purpose of CO_2 storage and EOR.

Strong project management is crucial to the success of any project. The PCOR Partnership project management team focuses on providing timely completion of milestones, quality deliverables, accurate and timely project reports as directed in the Federal Assistance Reporting

Table 2. Phase III Responsibility Matrix

Phase III Task Title	Task Leader
Task 1 – Regional Characterization	Wesley D. Peck
Task 2 – Public Outreach and Education	Daniel J. Daly
Task 3 – Permitting and NEPA Compliance	Lisa S. Botnen
Task 4 – Site Characterization and Modeling	James A. Sorensen
Task 5 – Well Drilling and Completion	John A. Hamling
Task 6 – Infrastructure Development	Melanie D. Jensen
Task 7 – CO_2 Procurement	John A. Harju
Task 8 – Transportation and Injection Operations	Melanie D. Jensen
Task 9 – Operational Monitoring and Modeling	Charles D. Gorecki
Task 10 – Site Closure	TBA
Task 11 – Postinjection Monitoring and Modeling	TBA
Task 12 – Project Assessment	Katherine K. Anagnost
Task 13 – Project Management	Charles D. Gorecki
Task 14 – RCSP WWG Coordination	Ryan J. Klapperich
Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project	James A. Sorensen
Task 16 – Characterization of the Basal Cambrian System	Wesley D. Peck

Checklist, and effective communication between the PCOR Partnership and DOE NETL management. All required deliverables, milestones, and project reports were completed on schedule during PY5. These included 25 required reports, achievement of mandatory milestones, and four quarterly progress reports.

In November 2011 and August 2012, the PCOR Partnership participated in the RCSP annual project review meetings in Pittsburgh, Pennsylvania, and hosted the 2012 annual meeting in Milwaukee, Wisconsin, to ensure that program goals are being met. Throughout PY5, the PCOR Partnership was represented at over 60 conferences and meetings and submitted 34 abstracts. The PCOR Partnership also prepared 25 (deliverable) technical reports, achieved five program milestones, and gave over 70 presentations (oral and poster combined).

The PCOR Partnership continued to post technical information about its program on its public Web site, which received nearly 4000 site visits from over 80 countries in PY5. The PCOR Partnership distributed over 1200 documentary DVDs and more than 1000 atlases in PY5. In addition, there were over 60 telecasts of the documentaries on public television and nearly 265 teachers heard the PCOR Partnership message and learned about CCUS. Through these efforts, the CO_2 storage community is kept informed of the PCOR Partnership's accomplishments and activities.

Project management cannot be considered complete without identification of technical and nontechnical risks that may threaten successful project implementation. Accordingly, the PCOR Partnership developed a programmatic risk management plan in April 2011 to document individual project risks, consequences, and impacts. During PY4, the EERC worked closely with the Fort Nelson demonstration site owners/operators to prepare a 2011 update to the 2010 first-round risk assessment (RA). In PY5, an internal, preliminary risk register was developed for the Bell Creek demonstration project. Risk management activities for the Bell Creek project will use the same risk management framework that is being applied to the Fort Nelson site. The final processes and procedures that are ultimately used are evolving in order to seamlessly integrate with the risk processes and policies of the industry partner, Denbury.

In BP4, the focus of the program is to inject CO_2 at commercial scale at the two demonstration sites. For each site, the critical steps/decision points are 1) securing a CO_2 source, 2) permitting for pipelines and injection, 3) infrastructure development, 4) CO_2 injection, and 5) MVA implementation. Several years of injection and monitoring will be required in BP4 to move into the BP5 site closure and project wrap-up activities.

The CO_2 source has been secured for both the Fort Nelson and Bell Creek sites. In both cases, the CO_2 source is a natural gas-processing facility. Spectra owns the gas-processing facility near the Fort Nelson site. The source of CO_2 for the Bell Creek site is the ConocoPhillips Lost Cabin Natural Gas-Processing Facility, and Denbury has secured the CO_2 from that facility until 2024.

Permitting of the sites required that the EERC complete DOE environmental questionnaires for both the Fort Nelson and Bell Creek demonstration projects. The Fort Nelson demonstration project received a categorical exclusion in 2010, and a categorical exclusion for

the Bell Creek demonstration project was granted in 2011. A permitting action plan was prepared for the Bell Creek project in August 2011 and described the regulatory and permitting steps taken by the EERC and Denbury to conduct the project.

The PCOR Partnership continues to establish and maintain excellent relationships with regional regulatory authorities. EERC staff participate fully in International Oil and Gas Compact Commission (IOGCC) efforts. In fact, John Harju, EERC Associate Director for Research, was appointed to the IOGCC Executive Committee and continued to serve until 2012. In addition, the PCOR Partnership hosted its fourth annual regulatory workshop in July–August 2012, where oil and gas and pipeline regulators met informally to develop strategies to work past state/provincial boundaries and to establish rules and regulations outside of federal mandate. These relationships will prove invaluable as the demonstration projects progress.

For the Fort Nelson CCS Project, the pipeline route is under development, and preliminary pipeline-permitting processes continued. For the Bell Creek demonstration project, construction of the 232-mile Greencore CO_2 pipeline to the Bell Creek oil field continued and is anticipated to be complete in late November 2012.

The success of the PCOR Partnership Program will be evidenced by a region that has a supportive population, an accommodating regulatory environment, and, ultimately, a vibrant commercial CCUS industry. Through its outreach and education activities, its rapport with regional regulators and federal decision makers, and its ongoing collaborative MVA activities with supportive partners, the PCOR Partnership is well on its way to achieving its goals.

This Annual Assessment Report provides information about the foregoing activities in more detail and is organized as set forth below:

- Progress update and budget status of the 14 tasks (Tasks 1–9 and 12–16) that were active in BP4, PY5 (October 1, 2011 – September 30, 2012)
- Accomplishments achieved during BP4, PY5 (October 1, 2011 – September 30, 2012)
- Description of planned BP4, PY6 (October 1, 2012 – September 30, 2013) activities

It should be noted that Tasks 10 and 11 will be initiated in BP5.

BP4, PY5 ACTIVITIES (2011–2012)

Progress Report

BP3 included the first 2 years of Phase III, with activities initiated October 1, 2007. Thirteen tasks were originally scheduled for Phase III. A new task, Task 14, was added during PY2 of BP3. Out of the 14 tasks, 12 tasks were active during BP4, PY3. In February 2011, DOE approved moving former Subtask 1.4 to a newly created Task 15 and added a new task, Task 16, as shown in Figure 3. Out of the 16 tasks, 14 tasks were active during BP4, PY4. No new tasks

were created in BP4, PY5, and 14 tasks were active (Tasks 10 and 11 will not begin until BP5). The progress update for the active tasks is presented within this section. This Assessment Annual Report (Deliverable [D] 57) details activities beginning October 1, 2011, through the end of BP4, PY5, or September 30, 2012.

Charles D. Gorecki is the overall EERC program manager and principal investigator (PI) and provides leadership in fully coordinating and integrating the activities of the PCOR Partnership. To facilitate the management of this project, task leaders were designated, as shown in Table 2.

Task 1 – Regional Characterization

The PCOR Partnership continues to refine the characterization of sources, geologic sinks, and infrastructure within its region. The goal is to further refine the assessment of the region's CO_2 production and storage potential in an effort to optimize source–sink opportunities within the region. This continued regional characterization will be used to refine capacity estimates for DOE NETL's national atlas and to provide context for extrapolating the results of the large-scale demonstrations.

Activities and Results

Phase III regional characterization efforts for BP4, PY5 (October 1, 2011 – September 30, 2012) are addressed below.

Review and Update Attribute Data for CO_2 Source Locations Within the Region

The PCOR Partnership maintains a database of significant stationary regional point sources of CO_2. The database is key in the development of CO_2 capture–transportation–sequestration scenarios that have the potential to reduce GHG emissions in the PCOR Partnership region. To maintain a reasonably current status, the data set undergoes an annual review during which new or missing sources are identified and added, CO_2 emission rates are updated, and facility locations are verified. In PY5, a summary was prepared based on the data review that took place between October 1, 2011, and July 31, 2012. Four primary data sets were used to update the PCOR Partnership CO_2 emission database: 1) Environment Canada Reported Facility Greenhouse Gas Data (Environment Canada, 2012); 2) U.S. Environmental Protection Agency (EPA) Air Markets Program Data online emission search engine (U.S. Environmental Protection Agency, 2012a); 3) Nebraska State government Web site "Ethanol Facilities Capacity by State and Plant" (Nebraska State Government, 2012); and 4) EPA Greenhouse Gas Reporting Program Data for Calendar Year 2010, released on January 11, 2012 (U.S. Environmental Protection Agency, 2012b).

As of July 31, 2012, the updated PCOR Partnership database contains 1033 sources that produce an estimated 620 Mt of CO_2 annually. This compares to the September 2011 values of 906 sources producing an estimated 606 Mt of CO_2 annually.

In 2008, the PCOR Partnership instituted a minimum CO_2 emission rate of 15,000 tons/yr for sources contained in the database. Many sources produced less CO_2 during the past calendar year as a result of efficiency gains, changes in production, etc. During this update, 17 sources were removed from the database because they no longer produced the minimum amount of CO_2 required for inclusion in the PCOR Partnership database.

Occasionally, the name of a source is found to have changed in an emission data set. This happened repeatedly this year because the EPA database listed the U.S. CO_2 emission sources under different names than they were listed in the other, older data sets used to build the PCOR Partnership database. The PCOR Partnership database was modified to reflect the name change of 333 sources since October 1, 2011.

Sources that no longer exist or that were found to be duplicate entries in the database were eliminated. There were a total of 66 such point sources in the PCOR Partnership database. On the other hand, 210 new facilities were found to be missing from the data set and were added to it. Figure 3 shows the locations of the new facilities.

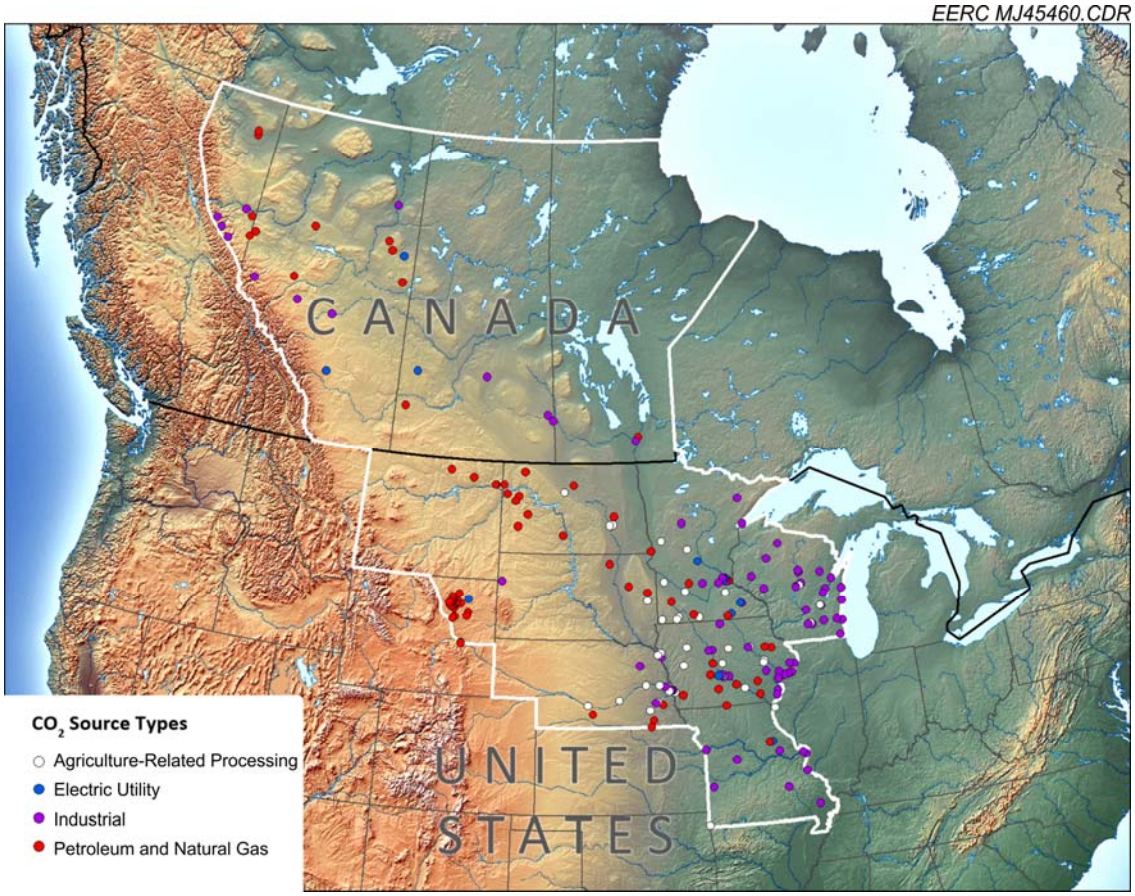


Figure 3. Location of the new facilities identified during PY5 database update.

Second Target Area Characterization (Rival oil field) Completed

In PY2, the PCOR Partnership completed a detailed geologic site characterization for its first target area, the Dickinson Lodgepole Mounds (including the Eland oil field) near Dickinson, North Dakota. In PY3, work began in the Rival oil field, located in northwestern North Dakota (Figure 4), continued throughout PY4, and wrapped up in PY5. This field has been identified as a candidate for tertiary CO_2 EOR activities and CO_2 storage and is currently home to an acid gas injection disposal unit in Burke County, North Dakota.

Site characterization and 3-D geologic modeling of the Rival Field were completed in PY4. Static 3-D geologic models were built with the goal of better understanding spatial distribution of reservoir properties across the 100-square-mile study area centered on the Rival Field. Twenty-eight thin sections were prepared from North Dakota Industrial Commission (NDIC) Wells 16409 and 13700 and prepared for petrographic analysis. In addition, five core plugs were cut from NDIC Well 16409 to estimate values for the following: bulk and grain density, porosity, permeability, and bulk mineralogy. These data, along with the historic data, were used to identify different macro- and microfacies and were then correlated to the geophysical logs.

Once the facies were identified, several well data normalization and petrophysical analysis techniques were performed on the geophysical logs available from the 312 wells. Five prominent tops were picked and correlated amongst 140 wells that passed the normalization and

Figure 4. Location of the Rival oil field in northwestern North Dakota within the PCOR Partnership region.

petrophysical analysis workflows, ultimately comprising the 3-D structural model. A petrophysical model was built with the following interpreted properties: effective porosity, net-to-gross (porosity), permeability, water saturation, temperature, and pressure. Random seeds were used to generate 31 realizations for each property where values were distributed across the model geostatistically using Gaussian random function simulation.

Volumetric EOR and CO_2 required were calculated based on original oil in place (OOIP), industry standard recovery and utilization factors, and a literature-derived formation factor. This resulted in 6.0–9.0 Mbbl of incremental oil from the Rival Field which required 1.5–2.9 Mt of CO_2 that would be ultimately stored.

A CO_2 Prophet model was calibrated using historic water injection data and simulated to make predictions for total CO_2 storage volume and incremental oil recovery within the Rival Member. Sensitivity analysis was performed, resulting in a total of 36 cases of simulation of which 23 were successful. 60-acre, 80-acre, and 100-acre spacing units were used, with 12 cases for each. Two patterns were simulated for each spacing unit, or six cases for each of the seven-spot and line drive patterns. Upon injection of 1 hydrocarbon pore volume (HCPV), the patterns continually showed an additional 13–15 Mbbl of oil (15%–18% OOIP), while 2 HCPV resulted in an additional 22.8–24.4 Mbbl of oil (26.9%–28.6% OOIP). The injection of CO_2 for EOR ultimately would result in an incidental cumulative storage of an estimated 2.5 to 3.5 million tons of CO_2.

This method, along with the volumetric EOR and CO_2 method, gives good estimations of the potential for incremental oil recovery in the Rival Field, although they do not replace calculations made by detailed history-matching and subsequent predictive simulations.

Refine Storage Analogs for Specific Geologic Horizons Within the Regional Basins

There are eight depositional basins lying fully or partially within the PCOR Partnership region. Efforts are under way to expand the number of assessed target formations in these basins. The largest of these efforts is aimed at characterizing the basal Cambrian saline system lying across the Alberta and Williston Basins. This effort was reassigned its own task (Task 16) in 2011.

Work with Geological Surveys/Oil and Gas Divisions

In PY5, regional characterization staff worked closely with Montana Board of Oil and Gas, the Nebraska Oil and Gas Conservation Commission, and the Wyoming Oil and Gas Conservation Commission to acquire updated cumulative oil production numbers for the fields and pools in the U.S. portion of the PCOR Partnership region. This effort included gathering reservoir values, such as OOIP, porosity, permeability, and production acres, that will be used to update the CO_2 EOR estimates for many fields. In addition, well log data collection for the Pine and Pennel oil fields along the Cedar Creek Anticline in southeastern Montana was initiated.

PCOR Partnership Atlas

The *PCOR Partnership Atlas* provides an introduction into the concept of global climate change and CCUS, as well as a regional profile of CO_2 sources and potential sinks across the nearly 1.4 million square miles of the PCOR Partnership region of central North America. This atlas is slated for revision on a biennial basis, i.e., 2009, 2011, 2013, etc., which are the alternate years for DOE NETL's update of the carbon sequestration atlas of the United States and Canada.

Efforts to reinvent the *PCOR Partnership Atlas, 4th Edition*, were undertaken in PY4. This included new images, new text, and a new size (for easier transportability). Because of the time needed to entirely retool the atlas, an extension was granted by DOE until January 31, 2012. After the appropriate approvals were received, 1200 atlases were printed in Fargo, North Dakota, and received by the EERC on June 8, 2012.

According to the *PCOR Partnership Atlas, 4th Edition*, the PCOR Partnership region has significant storage potential for long-term CO_2 storage—nearly 420 billion metric tons of CO_2 storage resources exist in the region's various types of primary geologic targets, namely EOR in selected oil fields, unminable coal seams, depleted oil fields, and evaluated saline formations.

The atlas continues to serve as an excellent resource as well as a valuable outreach tool. It is distributed to partners, visitors, educators, libraries, and conference attendees (Figure 5) and is available upon request, including via the public PCOR Partnership Web site. Approximately 1040 atlases (456 – 3rd edition [revised] plus 587 – 4th edition) were distributed in PY5. Overall, since its first printing in 2005, over 4240 atlases have been distributed.

Figure 5. "New for 2012" exhibit booth at the PCOR Partnership Annual Meeting, featuring the *PCOR Partnership Atlas, 4th Edition.*

Updating the DSS Web Site (www2.undeerc.org/website/PCORP)

Modifications and refinement to the partners-only Decision Support System (DSS, © 2007–2012 EERC Foundation®) are continually undertaken to ensure the timely dissemination of data and information as well as to help improve the quality and efficacy to our partners for their carbon management decisions. Efforts undertaken in PY5 include the following:

- Continually updated the home page to keep partners apprised of the latest PCOR Partnership activities.

- The Demonstration Project Reporting System (DPRS) was updated with data from the PCOR Partnership Phase III demonstration projects at Bell Creek and Fort Nelson. Each project has its own section (see next section).

- New PCOR Partnership products are regularly added to the database once they are approved for release to partners. Currently, the database contains over 860 products produced by the PCOR Partnership since its inception in 2003.

- An annual meeting section was added to the DSS. Highlights from the PCOR Partnership 2012 Annual Meeting and Workshop held September 12–14, 2012, in Milwaukee, Wisconsin, are showcased, and partners can download workshop and meeting presentations and handouts and see the winner of the 2012 PCOR Partnership Pioneer Award.
- As new partners join the PCOR Partnership, their company name and URL are updated.

- The Partner Directory is a database-driven page that is continuously updated to include the partners' most recent contact information.

- The GIS (geographic information system) portion of the Partners-Only Web site was modified to add functionality for information on oil fields in the region.

- A PDF version of the *PCOR Partnership Atlas, 4th Edition* was added.

- The Site Map is revised as changes to the DSS site are made.

It should be noted that the requirements for updated DSS reports (D9) in September 2013 and 2015 were deleted in September 2012. In PY6, updates to the DSS will be reported in the quarterly technical progress reports rather than in stand-alone reports.

Development of a DPRS

Collection of information specific to the demonstration sites is ongoing in an effort to populate a Web-based interface to house the data and facilitate communication and interpretation of the data. A DPRS was created to provide structured access to data from the PCOR Partnership Phase III demonstration projects at Bell Creek and Fort Nelson. Each project has its own section, with the following subcategories (bold indicates most dynamic):

- Background and Scope of Work
- Benefits to the Region
- Characterization Data
- Modeling
- **MVA**
- Risk Management
- Regulations and Permitting
- **Site Operations**
- Products

Current and planned activities for the Bell Creek demonstration project involve the development of the MVA protocol, baseline sampling at the site, and other initial site operations such as observation well installation. Therefore, these two sections of the Bell Creek demonstration project Web site (MVA and site operations) will be most dynamic, with new information added on a regular basis. In September 2012, planned additions to the DPRS included a thorough description of recent site operations, including installation of an observation well, coring and logging activities, downhole monitoring, and data analysis (Figure 6).

Planned additions, if any, to the Fort Nelson demonstration project Web site will be in the MVA section. The DPRS is an important addition to the DSS and will improve the nature and accessibility of the various demonstration project data and, ultimately, augment the well-established outreach and communication efforts of the PCOR Partnership Program.

It should be noted that the requirements for DPRS updates (D10) in September 2014 and 2016 were deleted in September 2012. In PY6, updates to the DPRS will be reported in the quarterly technical progress reports rather than in stand-alone reports.

Collaboration with Petroleum Technology Research Centre's (PTRC's) Aquistore Project

On December 16, 2011, the EERC sent a request to DOE for a modification to the scope of work and funding authorization to add a new subtask, Subtask 1.4 – Collaboration with PTRC's Aquistore Project (Figure 7). The PCOR Partnership proposed that this collaboration include site characterization; modeling and simulation; risk assessment; MVA development; and advisory board participation. In addition, the EERC proposed adding a new deliverable, D93, entitled "Geologic Modeling and Simulation Report for the Aquistore Project," due March 2013.

This proposed modification and funding authorization were approved by DOE in Modification 23 to Cooperative Agreement No. DE-FC26-05NT42592, issued June 18, 2012. The original period of performance was January 2012 through June 2013; however, because the award modification did not arrive until June 2012, a delayed start was requested. In September 2012, DOE approved the revised period of performance as July 2012 through June 2013. D93 was also extended from March 2013 to June 2013.

EERC BS45432.CDR

Coring Operations

An extensive coring and well-logging program was conducted at the observation well to provide critical data for geologic characterization and predictive simulation efforts. Data and samples collected during drilling operations provide critical information to evaluate how fluids will move and interact with the reservoir during CO_2 injection.

The Capstar 314 drilling rig.

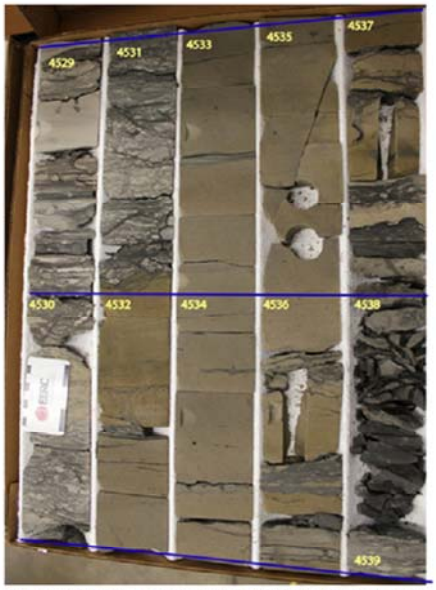
In total, 110 feet of 4-inch-diameter core was recovered along with forty-seven 1½-inch-diameter side wall core plugs. The wireline-conveyed sidewall cores were recovered at half-foot intervals over the majority of the Muddy sandstone interval in order to provide a quick turnaround analysis of critical rock properties and chemical testing. The full-diameter core is largely continuous and represents a portion of the Mowry shale (upper confining unit), the Muddy sandstone (reservoir unit targeted for CO_2 EOR operations), and the Skull Creek shale (lower confining unit). A spectral gamma ray log was run on the full-diameter core after retrieval, allowing for precise correlation with the wireline log suite. A tracer was added to the drilling mud prior to coring operations to determine fluid invasion into the core during recovery to better estimate native oil and water saturations present in the formation.

The core material is being analyzed to gain geologic and geomechanical insight into the reservoir and sealing formations. Sealing formations are being investigated to determine the effectiveness of the confining units to contain CO_2 during and after injection. The reservoir portion of the core is being investigated to garner key properties for characterization efforts and to determine how the reservoir and fluids will interact during CO_2 injection.

Ongoing core analysis includes the following:

- Thin-section petrographics
- X-ray diffraction, x-ray fluorescence, and scanning electron microscopy work
- Porosity
- Permeability
- Bulk density
- Grain density
- SCAL work

A Baker Inteq coring specialist removing a piece of full diameter core from the core barrel at the 0506 OW well site.



This photo illustrates a transition zone within the Muddy sandstone. The slabbed core allows for stratigraphy and facies description throughout the cored interval.

The initial core-testing results will be used to select intervals of interest for further special core analysis (SCAL) such as three-phase relative permeability to gas, oil, and water; threshold entry pressure; geomechanical testing; and uniaxial pore volume compressibility work. SCAL testing will provide additional insight into advanced geomechanical and reservoir properties associated with the dynamic reservoir and cap rock for reservoir fluid flow and geomechanical simulation activities.

Web page continues.

Figure 6. Planned addition to the Bell Creek DPRS in the category of site operations.

Figure 7. Aquistore project drilling rig (left), with the Boundary Dam Power Station nearby (right). Photo taken during the September 6, 2012, field trip held in conjunction with the 2012 CCS Binational Conference.

DOE NETL Carbon Sequestration Atlas of the United States and Canada (Atlas IV)

The primary purpose of Atlas IV is to update U.S.–Canada CO_2 storage potential and provide updated information on the activities of DOE's seven RCSPs as well as DOE's Carbon Storage Program and international CCS collaborations. In order to support Atlas IV efforts, the PCOR Partnership participated in multiple conference calls in PY5 to discuss progress of the data compilation and provided data via NATCARB (DOE NETL's distributed NATional CARBon Sequestration Database and Geographic Information System), including aggregated characterized saline aquifer data, recalculated regional coal capacity information, and new GIS layers. Atlas IV is anticipated to be released in PY6.

RCSP GIS Working Group

The task lead participated in the RCSP GIS Working Group conference calls, as scheduled. There were no working group meetings held in PY5.

North American Carbon Atlas Partnership (NACAP)

The United States, Canada, and Mexico have formed a joint CO_2-mapping initiative called NACAP. The goal of NACAP is for each country to identify, gather, and share data for CO_2 stationary sources and geologic storage sites. The NACAP members will then display these

sources and storage sites in a GIS for North America. Development of this GIS system supports the Carbon Storage Program, the objectives of the North American Energy Working Group (NAEWG), and current topics being discussed under the Canada–U.S. Clean Energy Dialogue. It is expected that this initiative will serve as a key opportunity to foster collaboration among the three countries in the area of CCUS. Results of this initiative were published in the 2012 North American Carbon Storage Atlas (NACSA, www.nacsap.org). Commitment to this effort is shared by EERC management staff and the regional characterization task lead.

During PY5, EERC management participated in the following NACAP activities:

- WebEx discussion on January 23, 2012, regarding the NACAP–6 meeting
- NACAP–6 meeting held January 30 – February 2, 2012, in Riviera Maya, Mexico (Figure 8)

EERC management and the regional characterization task lead each attended and presented at a workshop hosted by Mexico, including the following:

- Workshop of CO_2 Geological Storage and EOR held on March 21–23, 2012, in Mexico City, Mexico

Figure 8. Delegates at the 6th meeting of NACAP in Riviera Maya, Mexico.

- CFE/APEC Workshop, Introducing CCS in Earth Sciences, on June 26–29, 2012, in Mexico City, Mexico

EERC management and the regional characterization task lead each attended and presented at one of the following U.S.–Canada Clean Energy Dialogue meetings:

- Presented at the U.S.–Canada Clean Energy Dialogue 2 Bilateral Meeting on May 15 and MVA/measurement, mitigation, and verification (MMV) in Large-Scale CO_2 Injection Tests Workshop on May 16–17, in Mobile, Alabama.

- Presented at the 2012 CCS Binational Conference: Building a Business Case for CCS: Maintaining the Momentum for Large-Scale Demonstration Projects held September 5, 2012, in Regina, Saskatchewan, and participated in the field trip on September 6, 2012, to Estevan, Saskatchewan, to tour the Aquistore and Boundary Dam projects.

Core Analysis Basics Workshop

Prior to the PCOR Partnership 2012 Annual Meeting, a workshop entitled "Core Analysis Basics" was held on September 11, 2012, in Milwaukee, Wisconsin. This half-day introductory workshop highlighted various core analysis methods and their application to CO_2 storage characterization. The workshop included a field trip to an active nearby quarry, providing a unique opportunity to see a carbonate formation over 400 million years in the making. Over 60 people attended this workshop.

Training

Regional characterization staff attended the 2011 North Dakota GIS Users Conference in Grand Forks, North Dakota.

GIS programming staff attended the Esri International Users Conference in San Diego. This effort will bolster programming capabilities with respect to online GIS and DSS capabilities.

Task 2 – Public Outreach and Education

This task provides outreach and education mechanisms to raise awareness regarding CO_2 storage opportunities in the region as well as outreach to select target audiences concerned with the demonstration activities.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) are described as follows.

Meetings and Conferences

EERC employees attended 65 meetings/conferences at the regional, national, and international level. As a result, numerous external individuals and groups were exposed to the PCOR Partnership name, messaging, and informational materials, and numerous participants within the RCSP Initiative were updated on PCOR Partnership activities. The meetings/conferences featured audiences ranging from the general public, to educators, to scientists and researchers, to regulators and partners. Specifically, the PCOR Partnership peer and public outreach activities included 12 poster presentations and 64 oral presentations.

Outreach Material Distribution

The standard PCOR Partnership outreach packet contains some combination of the five documentary DVDs, the regional atlas, fact sheets, and other program materials. The materials are provided as part of presentations in select venues (e.g., teacher workshops), as part of acquainting new contacts with the PCOR Partnership Program, and by request through the PCOR Partnership public Web site or other pathways (e.g., telephone or e-mail). During PY5, the PCOR Partnership distributed over 1200 documentary DVDs and more than 1000 atlases as follows:

- PCOR Partnership documentary entitled "Nature in the Balance: CO_2 Sequestration" – 150
- PCOR Partnership documentary entitled "Reducing Our Carbon Footprint: The Role of Markets" – 101
- PCOR Partnership documentary entitled "Out of the Air: Into the Soil" – 129
- PCOR Partnership documentary entitled "Managing Carbon Dioxide: The Geologic Solution" – 501
- PCOR Partnership documentary entitled "Global Energy and Carbon: Tracking Our Footprint" – 412
- *PCOR Partnership Atlas, 3rd Edition, Revised* – 456
- *PCOR Partnership Atlas, 4th Edition* – 587

Outreach Planning

An update to the PCOR Partnership outreach action plan (D11) was prepared in March 2010. This plan describes the activities undertaken and products developed to help raise awareness of both the practice of CO_2 storage in general and the PCOR Partnership specifically. The next version of the plan is scheduled for March 2016.

Data Acquisition and Management

The outreach data management system is envisioned as an addition to the DSS, to consist of GIS-compatible databases. When completed, these databases will contain information needed to plan, track, and assess outreach actions as well as to produce thematic maps and other products to aid in outreach activities, including the Web site, PowerPoint presentations, fact sheets, and documentary products both at the regional level and for the areas of the demonstration projects.

During PY5, the tracking portion of the database framework was finalized and populated with an initial set of information, including number and venue of presentations as well as product distribution (e.g., DVDs and atlases). The next phase will feature the addition of data for such topics as public television documentary broadcasts and to incorporate the tracked data with a GIS-compatible database in order to expedite the development of thematic maps and to broaden the capabilities for planning, tracking, and assessment.

Public Web Site (www.undeerc.org/pcor)

Web Site Updates

The PCOR Partnership public Web site has been online since the summer of 2005. This Web site will be updated and expanded as appropriate, with major updates on a biennial basis.

An update (D13) was prepared July 31, 2012. This update included revisions to the Home Page and Educator Page and an expansion of the CO_2 Sequestration Projects section from one page to nine pages in order to include information on each of the Phase III projects and the Phase II verification test projects, as well as information on other CCUS projects in the PCOR Partnership region (Figure 9).

Each project has its own Web page. The four PCOR Partnership Phase II field validation "Learn More" links go to the existing PCOR Partnership fact sheets for each of these activities. The basal Cambrian "Learn More" link goes to the Geologic Characterization of the Basal Cambrian System page, which provides a description of this Phase III activity.

The Bell Creek "Learn More" link goes to the Bell Creek Integrated EOR and CO_2 Storage Project page. This page outlines the dual nature of the project—the Denbury EOR project and the collaborative effort with the PCOR Partnership to demonstrate CCUS under the RCSP. This page includes options to download the Bell Creek test site fact sheet (D15), the Bell Creek test site poster (D25), and the Bell Creek PowerPoint presentation (D18). Links on the page offer the visitor the opportunity to learn more about both projects by clicking on the "Learn More" hyperlink for each project. The visitor can also learn more about utilization of CO_2 for EOR by clicking on the "Learn About EOR" link, which goes to the existing CO_2 Flooding page.

Figure 9. Project information boxes that pop up when hot spots (project titles) are selected on the public Web site landing page.

The "Learn More" link for Denbury's Commercial CO_2 EOR Project goes to the Denbury's Commercial Project page, which provides a general description of the four main steps involved in the Bell Creek EOR project. This page also includes external hyperlinks to

Denbury's Web site (www.denbury.com) and to its Greencore Pipeline Web site (www.greencorepipeline.com).

The Fort Nelson "Learn More" link goes to the Fort Nelson CCS Feasibility Project page. This page describes the PCOR Partnership Phase III demonstration collaboration with Spectra near Fort Nelson, British Columbia. The page includes external links to the Carbon Sequestration Leadership Forum (www.cslforum.org/index.html?cid=nav_index) and to Spectra's Fort Nelson Web page (www.spectraenergy.com/Sustainability/Environment/Carbon-CapturStorage/).

Additional "Learn More" links have been created for PTRC's Aquistore project, SaskPower's Boundary Dam Integrated CCS Demonstration Project, Shell Canada's Quest CCS Project, and the Weyburn–Midale CO_2 Project.

Web Site Activity Tracking

Google Analytics is utilized to track activity for the PCOR Partnership public Web site. This Web analysis tool has played an integral part in understanding the online behavior of Web site visitors. Presently, site traffic includes both internal (EERC and PCOR Partnership staff) and external audiences.

Web Site Traffic

During PY5, there were 3971 visits to the public Web site, of which 2659 were unique visitors. New visitors made up 65% of the overall traffic to the Web site.

In PY5, the PCOR Partnership public Web site received traffic from 81 countries. Of the 3971 visits, 78% of the Web traffic was domestic. International traffic, as depicted in Figure 10, was primarily from Canada. Aside from the United States (3087), the countries with the highest number of visits included Canada (205), India (76), United Kingdom (59), Australia (49), China (32), France (26), Malaysia (26), and Brazil (20).

Web Site Traffic Sources

Google Analytics provides a breakdown of how visitors came to the PCOR Partnership Web site, also referred to as traffic sources. The three general sources of traffic include direct, search, and referral sites.

Direct traffic consists of those visitors who type in or enter the URL (www.undeerc.org/pcor). We are assuming that most of the direct traffic was from EERC staff, while most of the traffic from search engines and referring sites was external. As shown in Figure 11, direct traffic accounted for nearly 40% of the total for PY5. Because external audiences are the focus of the outreach and education effort, activities commenced to improve filtering to ensure that this information could clearly differentiate in the future between internal and external audiences.

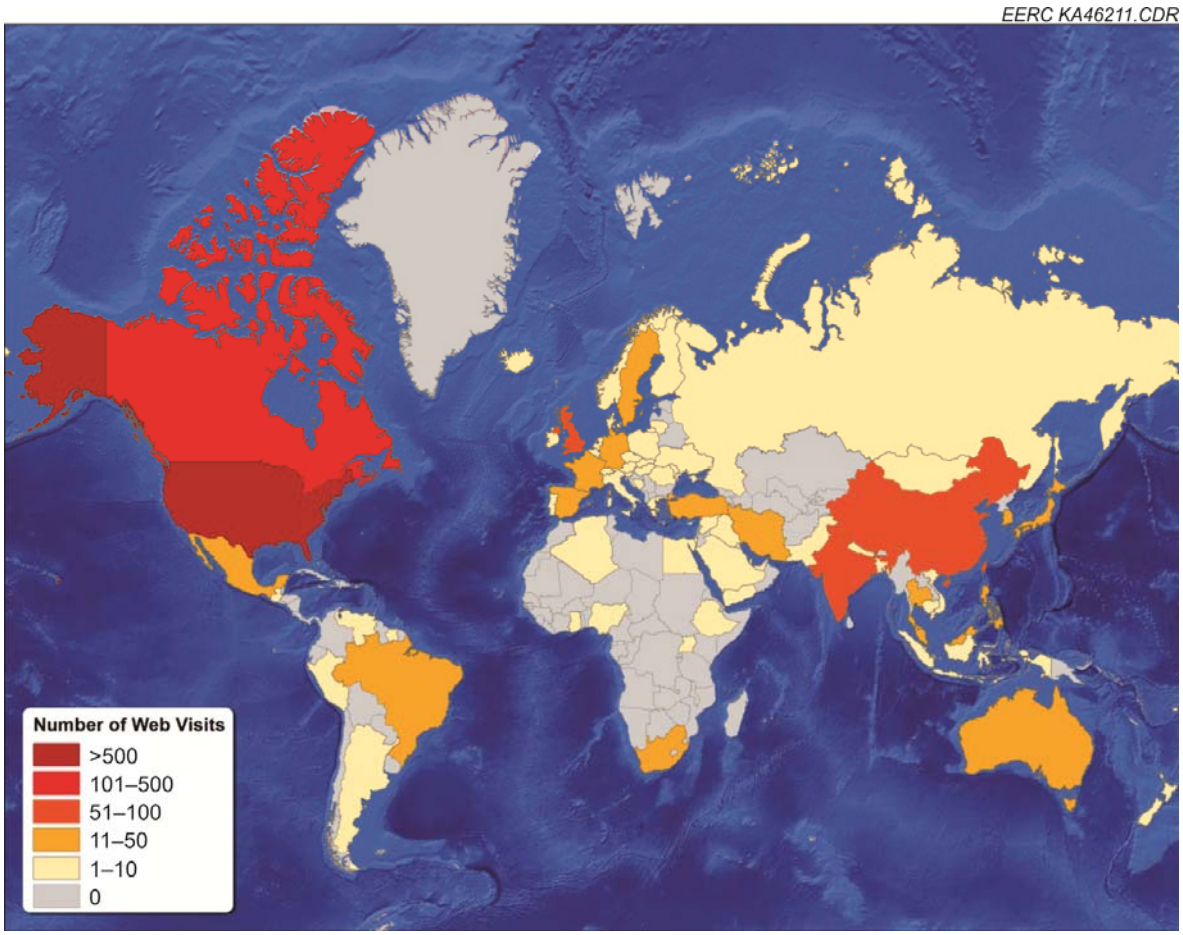


Figure 10. Map of PCOR Partnership global Web traffic (source: Google Analytics).

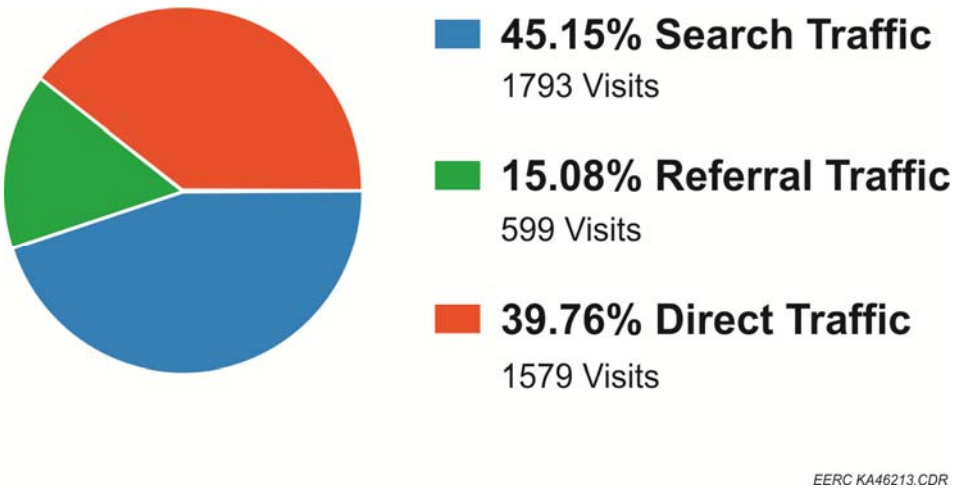


Figure 11. PCOR Partnership public Web site traffic (source: Google Analytics).

Search engine traffic refers to the use of keywords and accounted for just under half of the traffic. Google Analytics provides the keywords that visitors used to find their way to the Web site. Half of the keywords are specific to the EERC and the PCOR Partnership, and the other half are general terms such as "CO_2 sequestration." This informs us that the Web site is doing well at connecting people with the information they need. The search traffic is generated from both users who have an idea of what the PCOR Partnership is and does as well as users who do not yet know about our partnership.

Referral site traffic is traffic directed to the PCOR Partnership Web page from other sites via links. The top referring sites were the EERC home page, the DOE site, and the Massachusetts Institute of Technology site.

Nature of Visits

There were a total of 11,364 page views in PY5, and visitors spent an average time of 1:35 (1 minute, 35 seconds) on the PCOR Partnership public Web site. Figure 12 shows the distribution of Web visits from the states and provinces in the PCOR Partnership region. The percentage of new visits in the region was high. In fact, 12 areas showed percentages of new visits in excess of 50% (Table 3).

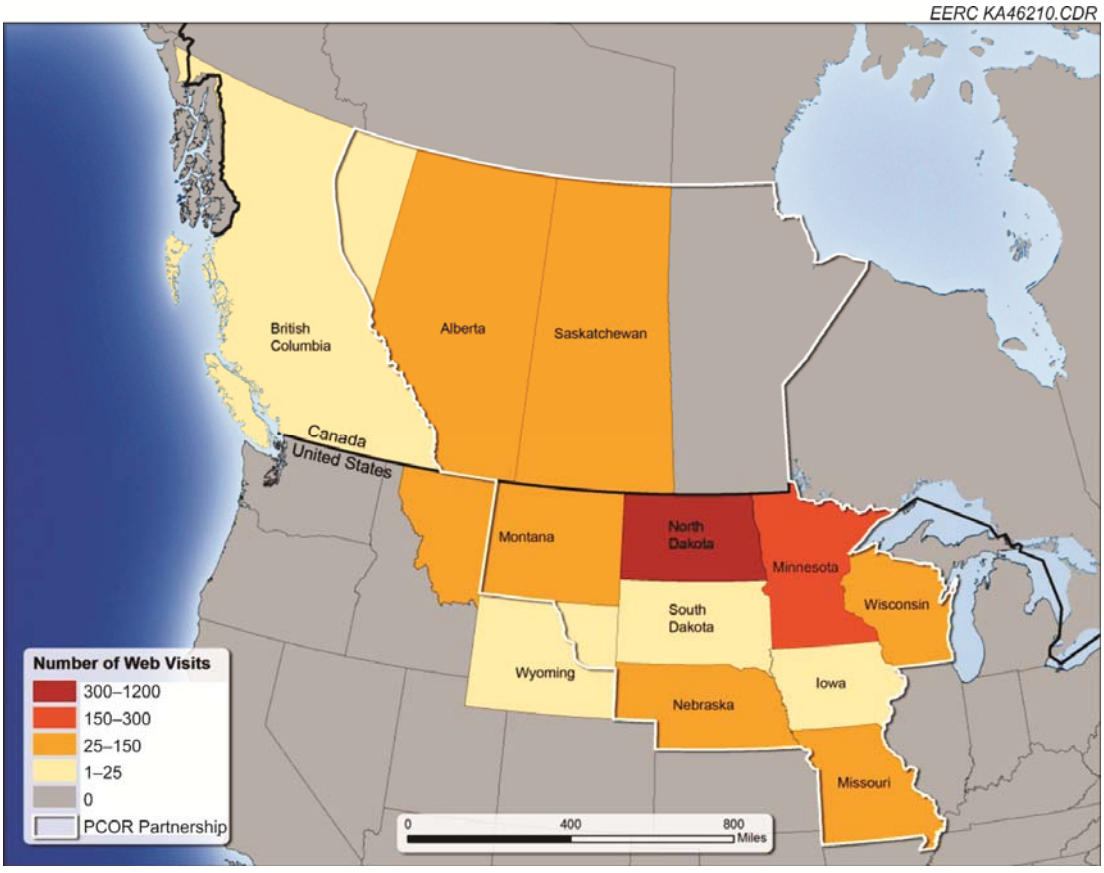


Figure 12. PCOR Partnership Web traffic by number of visits (Google Analytics).

Table 3. Visit Activity Within the PCOR Partnership Region

State/Province	Visits	Pages/Visit	Avg. Visit Duration, min	New Visits, %
North Dakota	1181	4.68	5:59	43.10
Minnesota	284	5.48	7:22	47.18
Alberta	106	3.40	4:41	70.00
Missouri	33	3.45	4:44	63.64
Montana	31	4.19	4:34	61.29
Saskatchewan	31	2.16	2:32	54.84
Wisconsin	31	2.03	1:23	77.42
Wyoming	20	1.55	3:43	65.00
Iowa	14	6.14	8:13	57.14
Nebraska	28	2.93	2:02	78.57
Wyoming	20	1.55	3:43	65.00
British Columbia	15	3.27	4:49	73.33
Iowa	14	6.14	8:13	57.14
South Dakota	12	4.50	6:20	91.67
Manitoba	0	0	0	0

*Arranged by the number of visits to the site.

The average time spent on the Web site was 3:20 (3 minutes, 20 seconds), slightly above the total average of all visits to the site. This demonstrates that there was a high level of engagement within the Web site.

Fact Sheets

Fact sheets have been created with general background information on the PCOR Partnership Phase III program and a profile on each of the demonstration projects. These fact sheets, along with the ones developed in previous phases, will be updated as needed. Other fact sheets may be developed as needed.

In March 2012, the fact sheet (D15) was updated. This fact sheet had originally been created in February 2011 in collaboration with Denbury for the Bell Creek Integrated CO_2 EOR and Storage Project.

PowerPoint Presentations

PowerPoint presentations have been developed for Phase III general activities as well as for each of the demonstration projects and for targeted outreach to specific audiences (e.g., educators). In PY5, all three general outreach PowerPoint presentations received attention.

The PowerPoint presentation created in collaboration with Denbury for the Bell Creek test site (D18) was updated in March 2012. This update included many new slides (now with fewer words and new pictures) and two video clips. Animation was incorporated into many of the

slides. A draft script was also prepared in order to convey the purpose of each slide. It should be noted that in September 2012, it was approved by DOE NETL that future updates to D18, due March 31 in 2013–2017, are no longer required as separate stand-alone presentations. Instead, we plan to give a variety of presentations related to this project and will report upon the presentations, including any updates, in the quarterly project reports.

The general Phase III information PowerPoint presentation (D17) was updated for general use in May 2012.

A modification of the Fort Nelson test site PowerPoint presentation (D19) was prepared in June 2012. This proposed update contained many of the slides from previous updates along with new photographs taken during the PPB shoot at Fort Nelson in February 2012 and additional slides from the PCOR Partnership general outreach presentation (D17) that provide background on geology and the science of carbon capture and storage. Many of the additional slides contained animation or video clips. A draft script was also prepared to accompany the presentation and explained the intent of the new, more visual slides. Spectra continues to review this presentation. Pending its approval, it will not be presented.

It should be noted that in September 2012, it was approved by DOE NETL that the future updates to D19, due June 30 in 2013–2017, are no longer required as separate stand-alone presentations. Instead, we plan to give a variety of presentations related to this project and will report upon the presentations, including any updates, in the quarterly project reports.

Outreach Working Group

The RCSP Outreach Working Group (OWG), comprising representatives from each of the seven regional partnerships as well as ad hoc representatives from DOE, recognizes the importance of conducting public outreach in tandem with successful field tests. Its members pool their experiences and resources in an effort to provide a foundation for future commercialization efforts and even more extensive outreach efforts. Based on contributions by the outreach leads of the seven regional partnerships, DOE NETL's outreach best practices manual (BPM) entitled "Public Outreach and Education for Carbon Storage Projects" was released in December 2009.

Examples of the PCOR Partnership's participation in the OWG during PY5 include the following:

- Participated in the monthly OWG conference calls and other calls as needed.

- Represented the OWG at the Society of Petroleum Engineers (SPE) Forum Series entitled "CO_2 Geological Storage: Will We Be Ready in Time?" October 9–14, 2011, in Vilamoura, Algarve, Portugal (www.spe.org/events/11fse3/pages/about/index.php). In addition to taking part in the intensive weeklong, invitation-only workshop, the task lead presented a poster on the RCSP outreach BPM and gave a presentation on the U.S. experiences and issues regarding CCUS-related outreach activities.

- Drafted and submitted an abstract to the International Conference on Greenhouse Gas Technologies (GHGT-11) on behalf of the OWG.

- Presented a poster entitled “Using Message Mapping to Enhance CCS Communication” on May 1, 2012, on behalf of the OWG at the 11th Annual Conference on Carbon Capture, Utilization & Sequestration (CCUS-11) in Pittsburgh, Pennsylvania.

- Served as moderator of the OWG-organized and led panel entitled “Best Practices in Public Outreach – What Have We Learned?” on May 1, 2012, during the CCS Public Outreach/Education technical session at CCUS-11.

- Participated in an OWG meeting held August 20, 2012, in Pittsburgh, Pennsylvania. The meeting focused on the OWG paper and poster to be presented on message mapping at the upcoming GHGT-11 scheduled for November 18–22, 2012, in Kyoto, Japan, as well as concepts for updating the 2009 version of the “Public Outreach and Education for Carbon Storage Projects” report.

Posters

Posters intended for a general audience are under development. In March 2009, a general outreach poster (D24) was completed. Efforts were undertaken for individual posters profiling the demonstration projects. In collaboration with Denbury, a Bell Creek test site poster (D27) bearing the heading “CO_2 Emissions Go to Work to Produce More Oil” was prepared in September 2011 for general audiences.

The Fort Nelson test site poster (D26), similar to the concept of the Bell Creek test site poster, diagramed the geology under the Fort Nelson demonstration project. The draft poster was prepared in March 2011 and was approved by Spectra in April 2012.

Documentaries and Video Products

A spectrum of video products are developed to meet the need of general and site-level outreach. Thirty-minute broadcast-quality documentaries are produced in partnership with PPB, are broadcast in the PPB market area, are made available to other public broadcasting markets for possible broadcast, are placed on the public Web site, and are available as DVDs. Video segments and products are intended for stand-alone use in meetings, in PowerPoint presentations, and on public Web pages.

Bell Creek Project-Related Filming

The Bell Creek (D21) demonstration site documentary is due in November 2014. In PY5, in conjunction with PPB, numerous activities were filmed at the Bell Creek test site. Virtually the entire month of December 2011 was spent filming monitoring well-drilling operations at the site. Highlights include video of drilling operations (time-lapse and real-time) as well as video of geological analysis of cuttings, analysis of drilling mud, and coring operations (Figure 13). In addition, a video short focused on the permanent downhole monitoring (PDM) equipment installation is under preparation. All told, approximately 27 hours of film was captured and has been, or is in the process of being, reviewed.

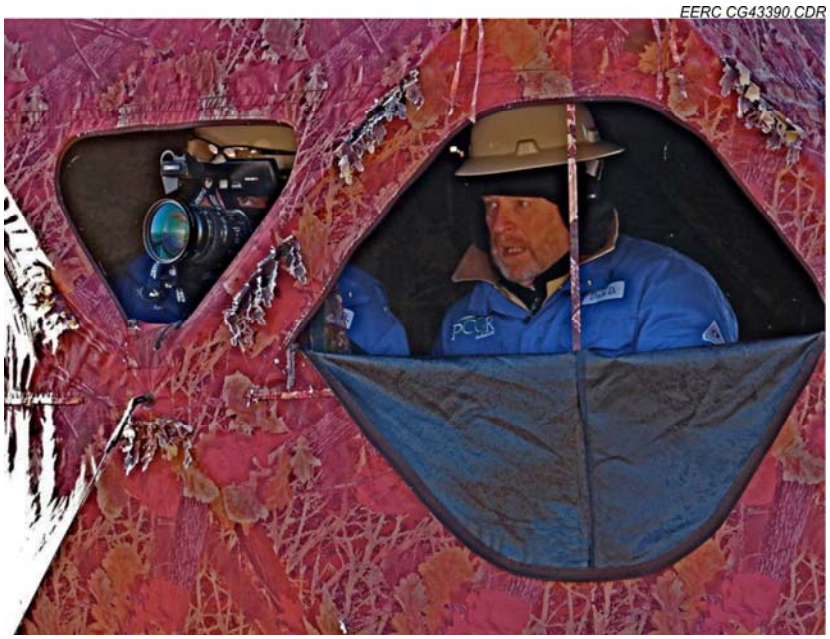


Figure 13. Dan Daly (EERC; right) and Dave Geck (PPB; left) at the Bell Creek site filming monitoring well activities (photo courtesy of Frode Tilden [PPB]).

In August 2012, Bell Creek core-related activities were filmed at the EERC laboratories. Additional filming trips to the Bell Creek oil field included the following:

- Spent 2 days (August 7 and 8, 2012) filming water- and soil-sampling activities with PPB at the Bell Creek site.

- Spent 2 days (September 4–6) filming 3-D seismic survey acquisition activities with PPB at the Bell Creek site.

- Spent 4 days (September 18–21) filming pipeline construction activities with PPB near the Bell Creek site.

Fort Nelson Project-Related Filming

The Fort Nelson (D22) demonstration site documentary is due in August 2015. In February 2012, in conjunction with PPB, activities in and around Fort Nelson, including at the Fort Nelson gas-processing plant and the Fort Nelson test site, were filmed (Figure 14). A review was completed of time code for more than 5 hours of raw footage shot by PPB, and a 2-minute scene sampler was produced for the Fort Nelson project review meeting held on June 6 and 7, 2012, in Grand Forks.

Figure 14. Jim Sorensen (EERC; second from the right) and Frode Tilden and Matt Olien (PPB; far left and far right, respectively) at the Fort Nelson site filming microfracture activities. Photo courtesy of Dave Moffatt (Spectra).

Aquistore Project-Related Filming

In response to an offer by the EERC as part of the Aquistore Project Communications Advisory Group, PTRC agreed to filming activities by PPB at the Aquistore site near Estevan, Saskatchewan, Canada, as well as interviews of project staff. As a result, 3 days (August 27–29, 2012) were spent filming on location, with additional filming planned for later in 2012 and perhaps in early 2013. A similar offer was made to SaskPower with respect to the Boundary Dam project.

Broadcast of Documentaries

During PY5, documentaries were broadcast in 18 states and four provinces, as shown in Figure 15. No PCOR Partnership documentaries were scheduled to premiere on public television in PY5. Because broadcast rights had expired in several areas, the broadcast numbers are significantly lower than in previous years and the number of prime time broadcasts were significantly lower. In total, there were 66 total telecasts of the documentaries in the United States and Canada (as compared to 221 telecasts in PY4). The number of telecasts for specific documentaries are as follows: “Global Energy and Carbon: Tracking our Footprint” (44), “Reducing Our Carbon Footprint: The Role of Markets” (10), “Out of the Air – Into the Soil: Land Practices that Reduce Atmospheric Carbon Levels” (8), and “Managing CO_2: the Geologic Solution” (4).

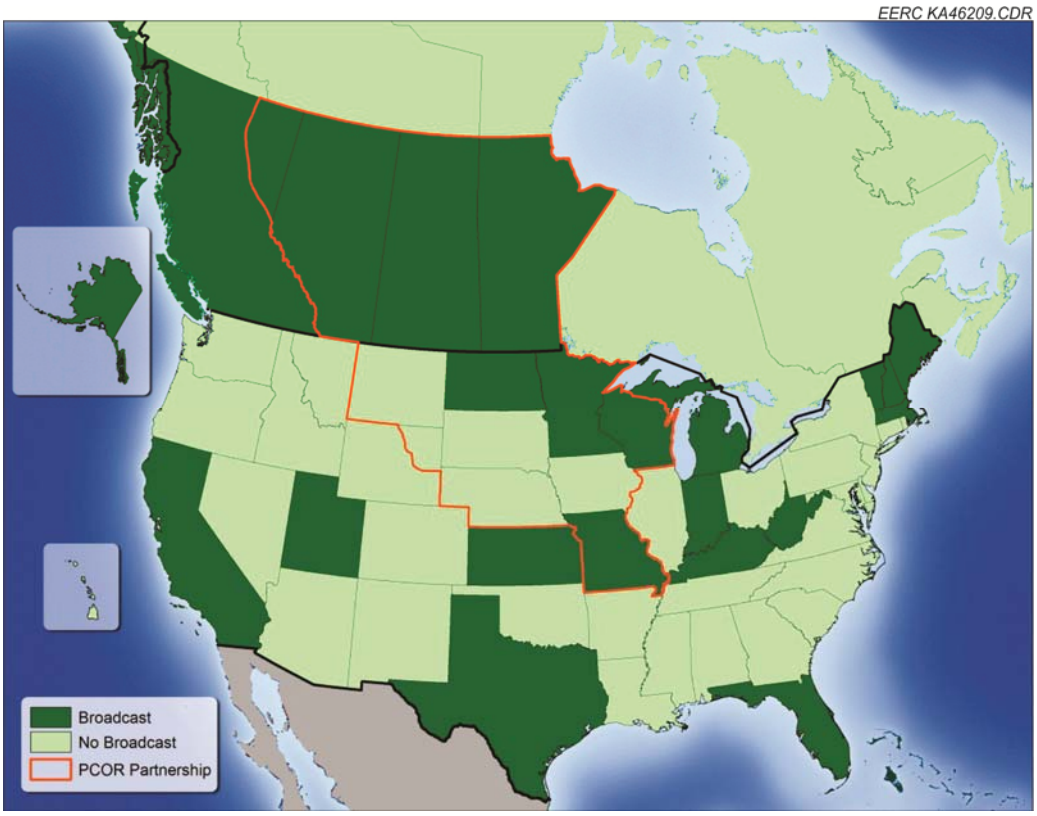


Figure 15. States and provinces airing broadcasts of various PCOR Partnership documentaries.

Outreach to Teachers and Librarians

In PY5, the PCOR Partnership participated in multiple teacher training workshops and education conferences (Figure 16). These activities focused on introducing the concept of CCUS, describing its role in the spectrum of carbon management strategies, and its relation to energy. In addition, the K–12 educators received a packet of PCOR Partnership materials (DVDs, atlas, Web site awareness). In a parallel effort, the PCOR Partnership expanded its efforts to provide materials to school, university, government, and public libraries.

Five teacher contact activities took place in North Dakota and one in Missouri. These included the following:

1. A 2-day CCUS-focused teacher training institute (presentation given, materials distributed).
2. A 2-day teacher training institute focused on CCUS and other energy activities in North Dakota (presentation given, materials distributed).
3. A 4-day coal-centric workshop presented by the North Dakota Lignite Energy Council (presentation given, materials distributed).
4. A 3-day oil-centric workshop presented by the North Dakota Petroleum Council (materials distributed).

Figure 16. Dan Daly presenting at a PPB teacher training institute in November 2011 at EERC headquarters in Grand Forks, North Dakota.

5. A 2-day minerals- and energy-focused workshop presented by the Missouri Minerals Education Foundation (presentation given, materials distributed).
6. A 2-day science teacher conference presented by the North Dakota Science Teachers Association (informal discussions, materials distributed).

A total of 264 teachers representing 186 schools in five states within the PCOR Partnership region were in attendance at these events. Figure 17 shows the geographic distribution of the teachers and their school districts (note: eight of the teachers participating in the 2-day CCUS-focused training had previously heard a PCOR Partnership presentation at a different workshop).

Librarian contact took place at the North Dakota Library Association Annual Meeting. Thirty librarians from all regions of North Dakota received materials for lending at their libraries. Based on the type of library, potential audiences for these materials include primary and secondary teachers and students; university faculty, staff, and students; and public library patrons.

Task 3 – Permitting and NEPA Compliance

The overall goal of Task 3 is to advance the regulatory and permitting framework for CO_2 storage projects in North America as well as to assist the demonstration site owners as necessary in obtaining the permits and approvals needed for the projects to comply with state, provincial, and federal requirements.

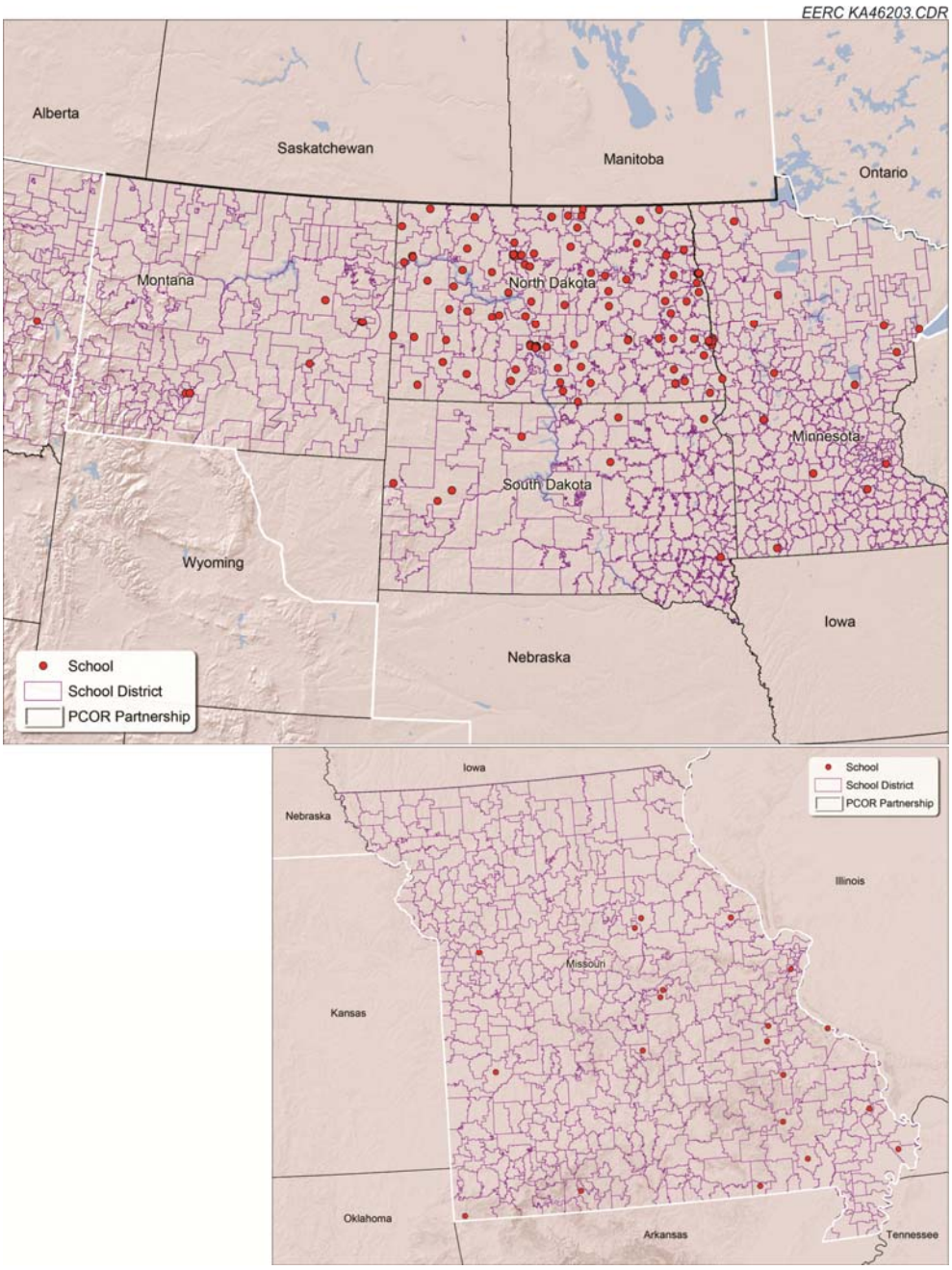


Figure 17. Distribution of teachers/school districts reached via participation in teacher-focused workshops and conferences.

Activities and Results

The PCOR Partnership continues to stay abreast of federal legislative actions occurring in the United States and Canada and follows the developments of various state, provincial, and regional initiatives. Internal documents that outline the activities of these groups are updated on a regular basis. Reviews continue of publications relating to the regulation of CO_2 sequestration,

MVA issues, and carbon market developments. Updates are provided to task leaders with regard to federal, state, and provincial actions. In addition, the regulatory section on the DSS is updated regularly.

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) are detailed as follows.

NEPA Environmental Questionnaires

The EERC was required to prepare the DOE environmental questionnaire (EQ) for both the Bell Creek and Fort Nelson demonstration projects (D27 and D28). DOE's NEPA implementation procedures require consideration of the potential environmental consequences of all proposed actions. DOE must determine, as early as possible, whether such actions require an environmental assessment (EA) or an environmental impact statement (EIS), or if they qualify for categorical exclusion. DOE suggested the most intensive NEPA scenario be addressed.

The Fort Nelson demonstration project EQ was submitted to DOE on April 2, 2008. A categorical exclusion was determined by DOE (for the performance period of 2008–2010) in February 2010. In December 2010, a categorical exclusion (for the performance period of 2011–2017) was received. In March 2011, an EQ for the Bell Creek demonstration project was prepared and submitted. On July 14, 2011, a categorical exclusion was granted.

It should be noted that in June 2012, Modification 23 to the DOE Cooperative Agreement was modified to include a revised NEPA clause. This modification was the result of DOE's initiative to modify the NEPA clauses in all its financial assistance agreements, whether or not categorical exclusions had already been granted.

Assistance in the Development of the EA

If DOE had determined that an EA was necessary for the Bell Creek project, the Cooperative Agreement with the EERC would be modified to reduce the award value for DOE to contract directly with an organization to prepare the appropriate document. However, the EERC received a categorical exclusion.

General Permitting Assistance

The EERC interfaces with relevant regulatory agencies within the PCOR Partnership region as well as with federal regulatory agencies (United States and Canada) to understand the regulatory framework for project implementation. The EERC determines anticipated permitting activities for potential projects in all states and provinces of the PCOR Partnership region.

North Dakota CO_2 Storage Workgroup

In an effort to obtain primacy from EPA for Class VI (geologic sequestration) wells, the North Dakota CO_2 Storage Workgroup worked with staff from the North Dakota Industrial Commission (NDIC) Oil and Gas Division to prepare rule changes to the North Dakota

Administrative Code §43-05-01, Geologic Storage of Carbon Dioxide. The North Dakota CO_2 Storage Workgroup consists of representatives of the oil and gas industry; lignite energy industry; several state agencies, including the North Dakota Department of Health; and the PCOR Partnership. Workgroup activities included participation in conference calls, one-on-one discussions, and meetings as well as providing review and comment on drafted documents.

On September 18, 2012, the North Dakota Department of Mineral Resources, Oil and Gas Division, filed a "Full Notice of Intent to Adopt and Amend Administrative Rules" and announced a public hearing for October 22, 2012, to address the proposed amendments to the North Dakota Administrative Code relating to the geologic storage of CO_2 (www.dmr.nd.gov/oilgas/FullNoticeC02.pdf).

Relevant EPA Rules

Mandatory Greenhouse Gas Reporting Rule, Subpart RR – Geologic Sequestration of Carbon Dioxide and *Subpart UU – Injection of Carbon Dioxide* (Final Confidentiality Determinations, August 2012)

> Subpart RR requires reporting of GHGs from facilities that inject CO_2 underground for geologic sequestration. Subpart UU requires reporting of GHGs from facilities that inject CO_2 underground for the purposes of enhanced oil and gas recovery or any other purpose other than geologic sequestration. Facilities that report under subpart RR for a well or group of wells are not required to report under subpart UU for that well or group of wells. The August 2012 action finalizes confidentiality determinations for most data elements to be reported under nine subparts; defers the deadline for reporting certain recently added data elements until 2013 or 2015 that are inputs to emission equations in three subparts; finalizes amendments to Electronics Manufacturing (subpart I) to remove the requirement for a facility to recalculate the previous reporting years' emissions and resubmit them to EPA where use of BAMM (best available monitoring methods) is allowed.

Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Well Project Plan Development Guidance (August 2012)

> This document describes the required elements of each of the five plans (Area of Review and Corrective Action Plan, Testing and Monitoring Plan, Injection Well-Plugging Plan, Postinjection Site Care (PISC) and Site Closure Plan, and Emergency and Remedial Response Plan) that prospective Class VI injection well owners and operators must submit with a permit application under the Class VI rule requirements.

An extensive review of EPA's Mandatory Greenhouse Gas Reporting Rule, Subparts RR and UU, and EPA's Class VI Well Project Plan Development Guidance was conducted in PY5. In particular, information was provided in May 2012 in response to a request received from DOE NETL for inclusion in a BPM on MVA on the monitoring requirements for both the Bell Creek and Zama projects under EPA's Class VI and Greenhouse Gas Reporting Rule Subparts RR and UU.

In addition, a more thorough analysis of the Bell Creek MVA program was conducted in association with the reporting requirements under Subpart RR.

Relevant Canadian Rules

A review was performed of the draft Canadian Standards Association (CSA) binational standard for the United States and Canada on the geological storage of CO_2. This draft standard proposes essential guidelines for regulators, industry, and others around the world involved with scientific and commercial CCS projects.

In February 2012, the task lead participated in Alberta's Webinar on Stakeholder Review of Draft Quantification Protocol for Fuel Switching in Mobile Equipment. This protocol will apply to projects involving the switching from conventional fossil fuels in mobile sources to less GHG-intensive fuels or electricity.

The task lead reviewed information regarding the North American Climate Exchange (NACX), which was originally founded as a Calgary-based exchange for trading Alberta Offsets. Canada's emission-trading and environmental compliance market is in its infancy, with only Alberta having an active regulated program for developing and trading of verified emission offsets and Quebec following with its Regulation Respecting Cap-and-Trade System for Greenhouse Gas Emission Allowances, coming into effect January 1, 2012. The Government of Canada has enacted the Renewable Fuels Regulations to mandate the use of at least 5% renewable fuel in gasoline and 2% in diesel and heating fuel blends, which has generated a market for renewable fuel compliance units. The NACX has been established in response to the need to provide an efficient and transparent spot market for trading such environmental compliance units and emission offsets.

Fourth Annual PCOR Partnership Regulatory Meeting

The 2009 regulatory meeting looked at the regulatory regime associated with subsurface injection of CO_2. At the meeting held in 2010, there was an effort to embrace a larger community by also addressing pipelines and focusing on the efficient movement of CO_2 throughout the region. In 2011, the meeting was held in conjunction with the IOGCC Midyear Meeting in Bismarck, North Dakota. The 4th Annual Regulatory Roundup Meeting was held on July 31 – August 2, 2012, in Deadwood, South Dakota. A continuing goal of the meeting was to continue to develop strategies to work past state/provincial boundaries.

13 people attended the 2012 meeting, including three representatives from the EERC and regulators from North Dakota, Montana, and Alberta, Canada. Also present were representatives of IOGCC; Melzer Consulting; The CETER Group; Bliss Consulting; and Premier Oil Recovery, LLC (Figure 18).

Figure 18. Attendees at the 4th Annual Regulatory Roundup held July 31 – August 1, 2012, in Deadwood, South Dakota.

Presentations were given on the following topics:

- Recap of 2011 Regulatory Roundup
- Discussion of relevant federal activity
- IOGCC update
- Provincial/state CCS updates
- National Enhanced Oil Recovery Initiative

Interstate Oil and Gas Compact Commission

- IOGCC is a multistate government agency that promotes the conservation and efficient recovery of domestic oil and natural gas resources while protecting health, safety, and the environment. The PCOR Partnership participates in IOGCC activities. In fact, John Harju is the past chair of IOGCC's Energy Resources, Research, and Technology Committee and serves on the Carbon Capture and Geologic Storage Task Force.

The task lead participated in the following IOGCC meetings in PY5:

- Attended the IOGCC Annual Meeting on October 15–17, 2011, in Buffalo, New York.

- Hosted a breakfast meeting for PCOR Partnership regulatory members, including representatives from Alberta, South Dakota, North Dakota, Montana, and the IOGCC, on October 17, 2011.

- Presented a PCOR Partnership overview to the IOGCC Public Lands Committee.

- Attended the IOGCC Midyear Meeting held June 3–5, 2012, in Vancouver, British Columbia, Canada.

IOGCC Carbon Geologic Storage (CGS) Task Force Activities

Through the efforts of the IOGCC CGS Task Force, the PCOR Partnership will address issues relating to liability (operational and postoperational) that remain as barriers to the establishment of state and federal legal and regulatory frameworks for CCUS. Clarification of attendant liability issues will remove significant barriers to CCUS deployment and thus provide prospective CCUS project developers with greater regulatory certainty, a necessary prerequisite for CCUS project development to move forward. Findings, recommendations, and guidance will be developed. IOGCC will communicate the CGS Task Force output to the public, along with state and local elected and administrative officials, industry representatives, prospective CCUS project operators and financiers, and other stakeholders through an outreach and awareness effort.

In June 2012, DOE issued a modification to the Cooperative Agreement authorizing a new subtask entitled IOGCC CGS Task Force Activities. Because the authorization was not received until June 2012, the period of performance was adjusted to July 1, 2012 – September 30, 2013. In accordance with the adjusted period of performance, several milestones were extended. They include the following:

- M37, IOGCC Task Force Subgroup Meeting 1 held, extended from June 30, 2012, to December 31, 2012.

- M37, IOGCC Task Force Subgroup Meeting 2 held, extended from December 31, 2012, to June 30, 2013.

- M38, IOGCC Task Force wrap-up meeting held, extended from December 31, 2012, to September 30, 2013.

- M39, IOGCC Task Force Editing Subgroup meeting held, extended from December 31, 2012, to September 30, 2013.

Plans are under way to hold a task force kickoff meeting on October 4, 2012, in Denver, Colorado. At that time, the two liability subgroups, i.e., an Operational Liability Subgroup and a Postoperational Liability Subgroup, will be formed to conduct CGS Task Force research.

Development of a Permitting Action Plan – Bell Creek Test Site

The EERC is required to develop a permitting action plan in conjunction with the site owner in accordance with relevant local, state, and federal regulatory requirements for the Bell Creek project. D29, permitting action plan, was completed in August 2011. Because permitting for the Bell Creek project has been secured by the site owner and operator, Denbury, there is no need for the EERC to prepare an update to the permitting action plan. Accordingly, in September 2012, the requirement for D75, updated Bell Creek permitting action plan, was eliminated. The requirement for D76, best practices manual – permitting, remains; but it was moved from Subtask 3.4, "Development of a Permitting Action Plan" to Subtask 3.3, "General Permitting Assistance" effective September 2012.

Fort Nelson Test Site

The PCOR Partnership has been supporting Spectra's permitting efforts for the Fort Nelson demonstration. Legislative and regulatory actions by the province of British Columbia are continually followed for the effect they may have on the Fort Nelson demonstration project.

Plug and Abandon Wells and Land Reclamation of Lignite Project Site

On February 14, 2011, the PCOR Partnership received approval for a cost increase to plug and abandon five wells located at the Lignite Field validation test site in the southeast quarter of Section 36 in Burke County, North Dakota. After permissions to proceed were received from the appropriate North Dakota regulatory agencies and approved subcontracts were in place, the process of plugging and abandoning the wells began in September 2011. Site reclamation activities commenced in October 2011, and over the next 2 years, weed spraying has been scheduled and fencing will be maintained (Figure 19).

Additional Conference Participation

- Attended the EERC's Air Quality VIII Conference held October 2011, in Arlington, Virginia, and coordinated a session on carbon management and policy.

- Attended the Groundwater Protection Council 2012 UIC Conference held January 23–25, 2012, in Houston, Texas (www.gwpc.org/meetings/uic/uic.htm).

- Attended the Enhanced Oil Recovery Institute (EORI) 6th Annual Wyoming CO_2 Conference held July 11 and 12, 2012, in Casper, Wyoming.

Task 4 – Site Characterization and Modeling

This task involves selecting the two field-based large-scale demonstration sites and developing baseline characterization data and petrophysical models for such sites.

Figure 19. Results of reclamation efforts at the Lignite Field validation test site (top: September 2011; bottom: June 2012).

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) are described as follows.

Fort Nelson Demonstration Site

The primary objective of the Fort Nelson project is to verify and validate the concept of utilizing one of North America's large number of saline formations for large-scale CO_2 injection, proposed to be up to 2 Mt a year, of anthropogenic CO_2 for permanent storage.

Carbon Sequestration Leadership Forum (CSLF) Recognition and Progress Reports

At its October 2009 London meeting, CSLF recognized the Fort Nelson CCS Project as a collaborative research project that meets CSLF priorities. Subsequently, and in coordination with Spectra, the PCOR Partnership submitted to the CSLF Secretariat required project status reports on April 8, 2012, and September 6, 2012. Progress at the Fort Nelson site was reported as follows:

- Project areas related to geological interpretation, laboratory evaluations, RA, and planning of MVA activities are all ongoing and progressing.
  - RA for Fort Nelson has been updated using an expert panel approach. The update is based on newly acquired data sets that facilitate a better interpretation of the extent and geometry of the injection target.
  - Laboratory evaluation of reservoir properties has been conducted on core samples obtained from the C61E test well. Relevant properties including mechanical strength, porosity, permeability, and capillary entry pressures have been obtained.
  - Geologic modeling and simulation have continued in this reporting period. A dynamic model based on the updated geologic model was constructed for the purpose of matching historical gas and water production, water disposal data, and scattered bottomhole pressures (BHPs) in areas near gas pools. Through the history-matching process, the geologic model was validated and improved.
  - Well workover and reservoir pressure testing at the existing exploratory well (C61E) were completed in the first quarter of 2012.
- Locations, geometries, and materials for the project's second exploratory well and for an extensive 3-D seismic program are planned for completion in 2012–2013.

Monthly and Quarterly Project Management Meetings

The project management teams from both the EERC and Spectra agreed to hold regular conference calls to monitor and maintain project progress. In PY5, conference calls were held on October 11, 2011; February 23, 2012; April 27, 2012; and August 16, 2012.

The project management teams also decided to hold in-person meetings to discuss progress. In PY5, meetings were held as follows:

- December 13 and 14, 2011, in Calgary, Alberta, Canada; topics discussed included the following:
  - Status of winter drilling and seismic survey activities
  - RA-driven MVA: the Bayesian approach
  - Restatement of project goals and the project master schedule
  - Potential meeting with DOE in early 2012
  - Modeling update
  - Well integrity report
  - Regulatory update

- June 6 and 7, 2012, in Grand Forks, North Dakota; Topics discussed included the following:
  - Geology update
  - Modeling update
  - MVA/Bayesian approach update
  - Status of Canadian government funding and related business case agreements
  - Public outreach update
  - Overview of British Columbia Oil and Gas Commission meeting and regulatory update
  - Overview of Winter 2012–2013 activities
  - Project master schedule review

- A meeting was also held at DOE NETL headquarters on March 20, 2012, in Pittsburgh, Pennsylvania. Representatives from DOE NETL, Spectra, and the EERC were present. The following items were discussed:
  - Spectra's business plan for the Fort Nelson project.
  - Spectra's schedule for the project, including a new target date for injection.

In-House Project Update Meetings

In an effort to keep the EERC project management team updated and coordinate activities, in-house meetings were scheduled on the following dates: October 10, 2011; October 24, 2011; November 4, 2011; November 21, 2011; January 4, 2012; February 13, 2012; March 26, 2012; June 5, 2012; August 29, 2012; and September 26, 2012. At these meetings, action items were reviewed, deliverables and reports were discussed, and project updates were given.

Fort Nelson Test Site Baseline Geology Determination

Fort Nelson test site baseline geology determination will include:

- Development of a site geological characterization experimental design package (D37, December 2007) describing the specific approaches and analytical techniques that will be used to conduct the activities.

- Collection, evaluation, and interpretation of historic data sets. Databases from Spectra and provincial regulatory agencies have been mined to gather a variety of data including, but not necessarily limited to, drilling records of selected oil and gas exploration and production wells in the Fort Nelson area and geologic and geophysical information for the Fort Nelson area, including maps, cross sections, and geophysical surveys.

- A site characterization report for the Fort Nelson site (D65, January 2012) has been prepared.

Fort Nelson Test Site – Site Characterization Report

Site characterization must be conducted prior to large-scale injection of CO_2 at the Fort Nelson test site. Effective characterization supports modeling, RA, and MVA programs that will constantly evolve to suit the project's needs. Site characterization activities have been conducted to address three critical issues affecting the viability of the Fort Nelson test site: 1) the capacity of the target formation; 2) the mobility and fate of the CO_2 at near-, intermediate-, and long-term time frames; and 3) the potential for leakage of the injected CO_2 into overlying formations and/or the near-surface environment.

Geochemical, mineralogical/petrophysical, geomechanical, and hydrogeological data have been collected for the purpose of supporting modeling, RA, and MVA activities. The geology, stratigraphy, and lithology have been evaluated, delineated, and described for the entire sedimentary succession from the base of the Devonian-age Presqu'ile reef complex to the ground surface for the Fort Nelson area. The structural elements of the reef complex have been investigated to identify any existing faults and/or fractures that would allow migration of any reservoir and/or injected fluids out of the storage reservoir. On this basis, a geologic model has been built, with particular attention given to the Devonian injection interval and overlying and underlying sealing formations.

Key findings of the characterization activities to date include the following:

- The Sulphur Point and Keg River Formations appear to have adequate storage- and injectivity-related properties to serve as primary sinks.

- The Fort Simpson and Muskwa Formations appear to have the tightness, competency, thickness, and lateral continuity necessary to be the primary seals.

- The Slave Point Formation has been disqualified as a primary potential sink because of the proximity of commercial gas fields that occur within it.

- Evidence suggests the Slave Point, Sulphur Point, and Keg River Formations are in hydraulic communication (laterally and vertically) with each other.

- Surface, shallow subsurface, and deep subsurface characterization data are limited because of the remote, inaccessible nature of the Fort Nelson area and because of the lack of hydrocarbons in the area being considered for CO_2 storage (Figure 20).

- The storage capacity of the Presqu'ile reef complex in the Fort Nelson area has been estimated to range from 100 to over 240 million tonnes of CO_2.

- It is anticipated that future characterization activities will include drilling and testing of a new exploratory well, collecting new seismic survey data, and conducting laboratory-based geochemical and geomechanical investigations.

IEAGHG Expert Panel Peer Review Milestone Completed

One of the recommendations received following the 2011 IEA GHG R&D Programme Expert Panel Review of the Fort Nelson project was as follows:

"R3: Site characterization: more effort required to understand thickness and permeability variations of the reservoir; this is important due to likely impact of heterogeneity on injectivity and capacity."

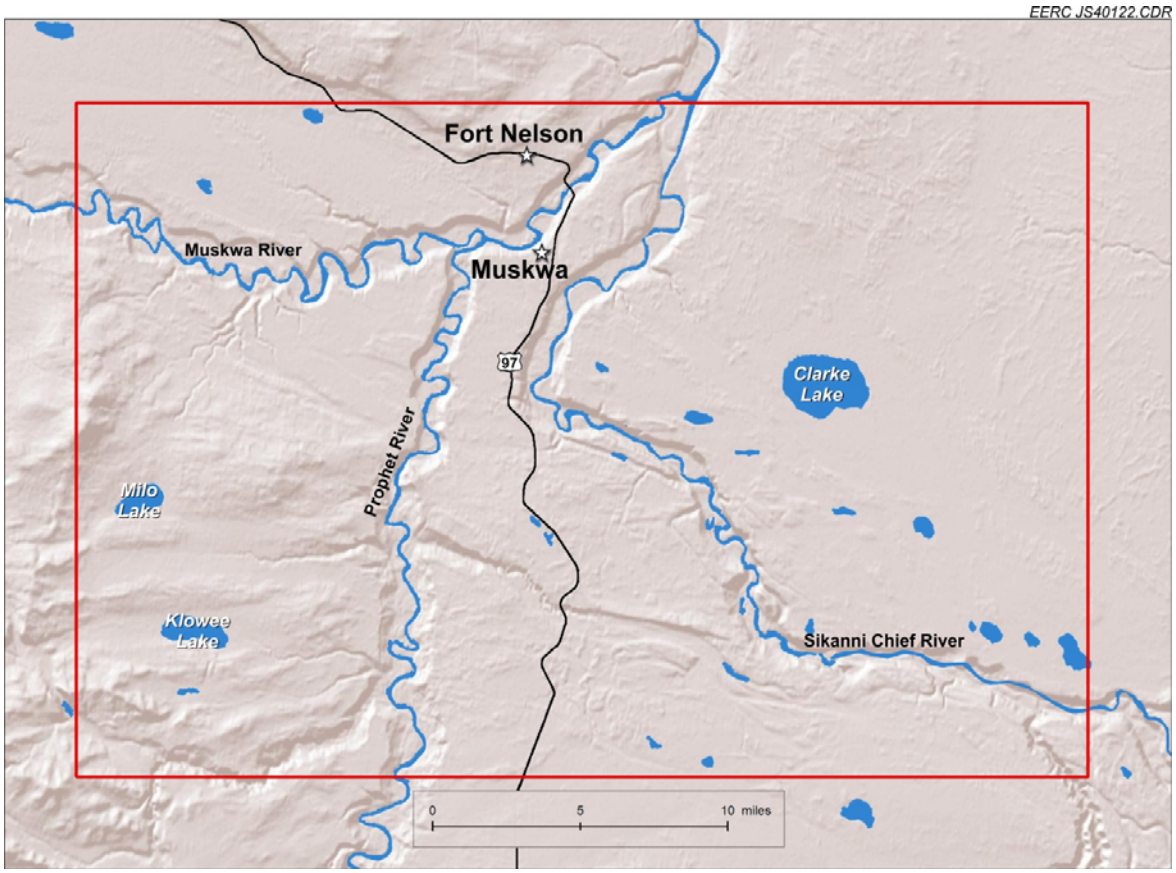


Figure 20. Represents surface features (lakes, rivers, roads) of the Fort Nelson study area.

Completion of this recommendation was due by September 30, 2012. A written explanation of activities performed toward this site characterization included the following:

A description of site characterization activities can be found in D65, Fort Nelson test site – site characterization report, draft dated January 2012.

Unfortunately, the site owner–operator did not drill any new exploratory wells during the winter 2011–2012 drilling season, and it announced in September 2012 that it will not be drilling during the winter 2012–2013 drilling season either. However, during the week of February 27 – March 2, 2012, the site owner–operator did conduct field-based characterization activities in the C-47-E exploratory well. These efforts were part of the ongoing geological characterization of the Fort Nelson CCS Project area. The efforts included reentry of the C-47-E well and the deployment of wireline pressure measurement tools to acquire formation pressure data. Formation pressure data were obtained for selected zones within potential CO_2 injection target formations and overlying sealing formations. The data generated by these activities will be applied toward future modeling efforts.

The static geologic model was updated based on commercially available well data, acquisition of existing 2-D and 3-D seismic surveys, log analysis, and core results. It has resulted in a more realistic static geologic model (Version 3) of the test site. The dynamic model based on the completed Version 3 geologic model was constructed for the purpose of matching the historical gas and water production, water disposal data, and BHPs in nearby areas to the results generated by the dynamic simulations. Through the history-matching process, the geologic model was validated and improved by decreasing the realistic range of several key geologic properties, including permeability, fault transmissibility, vertical-to-horizontal permeability ratio (k_v/k_h), and others.

Both injection locations (C-47-E and C-61-E) appear to have sufficient capacities to accommodate target injection volumes. However, the location C-47-E was determined to be a potentially better option compared to C-61-E because the injected sour CO_2 had a more contained CO_2 footprint and did not contact the adjacent gas pools during the 100-year simulation period. The BHPs in the C-47-E location were predicted to be 1000 to 3000 kPa lower than the BHPs at the C-61-E location (August 2011).

As described in D41, Fort Nelson test site – preliminary geochemical observations, draft report dated June 2012, a screening-level geochemical laboratory test program was conducted (2009 through 2011) at the EERC to investigate the theorized and potential effects of the injection of 100% CO_2 and sour CO_2 (i.e., a mixture of CO_2 and H_2S ranging from 86.5% CO_2 and 13.5% H_2S to 95% CO_2 and 5% H_2S) on the cap rock, transition-zone rock, and reservoir rock. Overall, the results of this screening geochemical study suggest that adequately understanding dissolution and precipitation reactions will require further investigation through a series of more detailed, targeted geochemical and geomechanical investigations.

Fort Nelson Test Site Geochemical Evaluations and Modeling

Laboratory tests have been conducted on samples of the target injection formation and key sealing formations under reservoir conditions to assess the geochemical reactions anticipated to occur between the injected gas and the rocks and fluids of the reservoir and seal. Mineral compositions have been obtained using x-ray diffraction (XRD), x-ray fluorescence (XRF), and scanning electron microscopy (SEM) techniques. Samples of fluids from key formations in the selected oil field were collected and analyzed for major and minor constituents. Laboratory results were used to refine geochemical models which will be integrated with CO_2 fate predictive modeling efforts. The results of these activities were presented in a geochemical report (D41) in June 2012.

Fort Nelson – Preliminary Geochemical Observations

A screening-level geochemical laboratory test program was conducted (2009 through 2011) at the EERC to investigate the theorized and potential effects of the injection of 100% CO_2 and sour CO_2 (i.e., a mixture of CO_2 and H_2S ranging from 86.5% CO_2 and 13.5% H_2S to 95% CO_2 and 5% H_2S) on the cap rock, transition-zone rock, and reservoir rock from Spectra's Fort Nelson CCS Project in northeastern British Columbia, Canada. The primary goals of this program were as follows:

- Identify the predominant mineral phases of the potential sink and seal formations.
- Determine possible interactions and mineralogical changes within the cap rock, transition-zone rock, and reservoir rock when exposed to CO_2 and sour CO_2 at near- and far-from-wellbore reservoir conditions.
- Determine the mineral dissolution and precipitation potential resulting from the exposure of the cap rock, transition-zone rock, and reservoir rock to CO_2 and sour CO_2.
- Determine potential changes in reservoir fluid properties as a result of CO_2 and sour CO_2 injection into the geologic storage reservoir(s).

Samples (drill cuttings) representing approximately 400 meters (m) of stratigraphy were collected from exploratory well c-61-E in April 2009 for use in the geochemical laboratory test program (Figure 21). Of the 160 vials of drill cuttings, a total of 26 samples were collected for further evaluation. The depth interval for the sampling program extended from 1840 to 2240 m and consisted of the following six formations, moving from the top to the bottom:

- Fort Simpson shale (cap rock formations), approximate thickness of 200 m, 11 samples.
- Otter Park shale, Upper Slave Point dolomite, and Lower Slave Point dolomite (transition-zone formations), approximate thickness of 150 m, ten samples.
- Sulphur Point dolomite and Upper Keg River dolomite (reservoir rock formations), approximate thickness of 50 m, five samples.

Figure 21. Example of as-received drill cuttings from exploratory well c-61-E.

The EERC developed a baseline mineralogical and petrophysical characterization profile for this suite of samples using a combination of the following analytical techniques:

- XRD (bulk mineralogy)
- XRF (elemental analysis)

- SEM linked with energy-dispersive spectroscopy (EDS) (mineralogical identification and rock fabric description)

- Inductively coupled plasma–mass spectrometry (ICP–MS) (major ion abundance in brine)

The data and interpretations that resulted from this screening geochemical study have been presented in D41, which is currently being reviewed by Spectra.

Geomechanical Rock Properties and Stress Regime Determination for the Fort Nelson Test Site

The geomechanical properties of the reservoir and cap rock and stress regime in the area will be determined to assess the mechanical integrity of the system and potential for rock fracturing. An in-depth review of available information on the stress regime and structural features in the area of the reservoir will be conducted to identify structures such as faults or dissolution areas. In PY5, work continued on development of the geomechanical model and the associated data collection for the geomechanical simulation, including the lab data, equivalent formation data, and expected data.

Fort Nelson CCS Project Risk Management Plan (RMP)

Risk management activities were relocated to Task 9.

Bell Creek Demonstration Site

The Bell Creek oil field in southeastern Montana has been identified as a PCOR Partnership Phase III demonstration site. Detailed subsurface mapping and characterization are being conducted in advance of a large-scale combined CO_2 EOR and CO_2 storage project injection. Site characterization activities will be conducted to develop predictive models that address three critical issues to determine the ultimate effectiveness of the target formation: 1) the capacity of the target formation, in this case, an oil reservoir within an established oil field; 2) the mobility and fate of the CO_2 at near-, intermediate-, and long-term time frames; and 3) the potential for out-of-zone migration of the injected CO_2 outside of the field or into overlying formations and/or the surface environment. Key site characterization parameters that are being addressed include properties of the reservoir and seal rocks, properties of the fluids in the reservoir and overlying fluid-bearing formations, and the production and operational history of the target oil reservoir.

In September 2012, after reevaluation of scheduled activities associated with the Bell Creek test site, several deliverables and a milestone were changed. They include the following:

- D33, entitled Geochemical Final Report, has been renamed to Preinjection Geochemical Report and remains due March 31, 2013.

- M12, entitled Geochemical Work Completed, has been renamed to Preinjection Geochemical Work Completed and remains due March 31, 2013.

- D64, entitled Site Characterization Report, has been extended from September 30, 2012, to August 31, 2013.

- D96, entitled 3-D Seismic Acquisition and Characterization Report, remains due June 30, 2013.

In-House Project Update Meetings

In an effort to keep the EERC project management team updated and coordinate activities, in-house meetings were scheduled on the following dates: October 3, 2011; October 17, 2011; November 2, 2011; November 28, 2011; February 6, 2012; March 8, 2012; April 16, 2012; June 11, 2012; July 23, 2012; and September 17, 2012. At these meetings, action items were reviewed, deliverables and reports were discussed, and project updates were given.

Bell Creek Test Site Baseline Geology Determination

Bell Creek test site baseline geology determination work includes the following:

- Development of a geological characterization experimental design package (D31, January 2011) that describes specific approaches and analytical techniques.

- Collection, evaluation, and interpretation of historic data sets.

- Acquisition, evaluation, and interpretation of new data sets, including data collected from field-based site characterization activities. Field-based site characterization activities may include, but are not necessarily limited to, core collection and analyses, well logging, and the application of selected geophysical survey techniques. This activity will consist of a joint acquisition (PCOR Partnership and Denbury) of a 3-D surface seismic survey centering on Phase 1 and surrounding areas. These data will be incorporated into the geologic model and injection simulation work in order to better predict CO_2 migration pathways, assess project risks, and aid in the monitoring of CO_2 migration in the subsurface.

  - The seismic source testing took place in December 2011 in the Bell Creek Field.
  - The 3-D seismic survey acquisition activities took place in September 2012.

- A report on the specific characterization of the Bell Creek oil field to be used for the injection program (D64) will be prepared.

- Creation of a geologic model of the strata at the appropriate scales.

- Drilling, logging, testing, and coring of monitoring wells in the injection and overlying formations.

Production and Injection Simulation Work Plan Initiated (M16, January 2012)

Production and injection simulation activities are being conducted, and the work plan will include the following:

- Characterize and model the study area using advanced geologic modeling.
- History-match Bell Creek static model parameters regarding production and injection history; pressure, volume, temperature (PVT) tests; and address and predict minimum miscibility pressure (MMP).
- Utilize predictive simulations to aid in the development of effective strategies for monitoring an integrated CO_2 EOR and long-term CO_2 storage project.
- Determine the area affected by the injection process to guide MVA activities.
- Construct a 3-D-coupled geomechanical model to identify, anticipate, and evaluate the potential risk for out-of-zone fluid migration caused by reservoir integrity in order to guide the monitoring program.

A variety of activities focused on geologic modeling and reservoir simulation history matching and prediction were initiated in December 2010. These activities include the following:

- PVT history matching between laboratory data and predicted results for three fluid samples are in agreement. Initial results, based on current information, indicate that miscibility for oil samples can be achieved at approximately 2800 psia.
- A 3-D geologic model was constructed using a stratigraphic framework, yielding a structural model into which rock and fluid petrophysical properties were populated (Figure 22). The current geologic model is only of the Phase 1 area. A full field model and simulations will be started in spring of 2012. This 3-D geologic model, which will be updated based on new data acquired during the installation of the monitoring well, was used as input for history matching and will provide the groundwork for future predictive reservoir simulations.
- Efforts for the reservoir simulation study were initiated in July 2011 and are under way using GEM, a 3-D compositional reservoir simulator developed by Computer Modelling Group (CMG). The model includes 67 production wells, 35 injection wells (31 of them are converted injection), and one monitoring well.

Bell Creek Test Site Baseline Hydrogeology Evaluation

A baseline hydrogeological experimental design package (D34) describing the specific approaches and techniques that will be used to conduct project activities was completed in May 2011. Existing groundwater well logs in the Bell Creek Field were reviewed to determine suitability for sampling. Development began on a near-surface (surface waters, groundwater, and soil gas) testing plan. Actual sampling activities began in November 2011 in conjunction with Task 5.

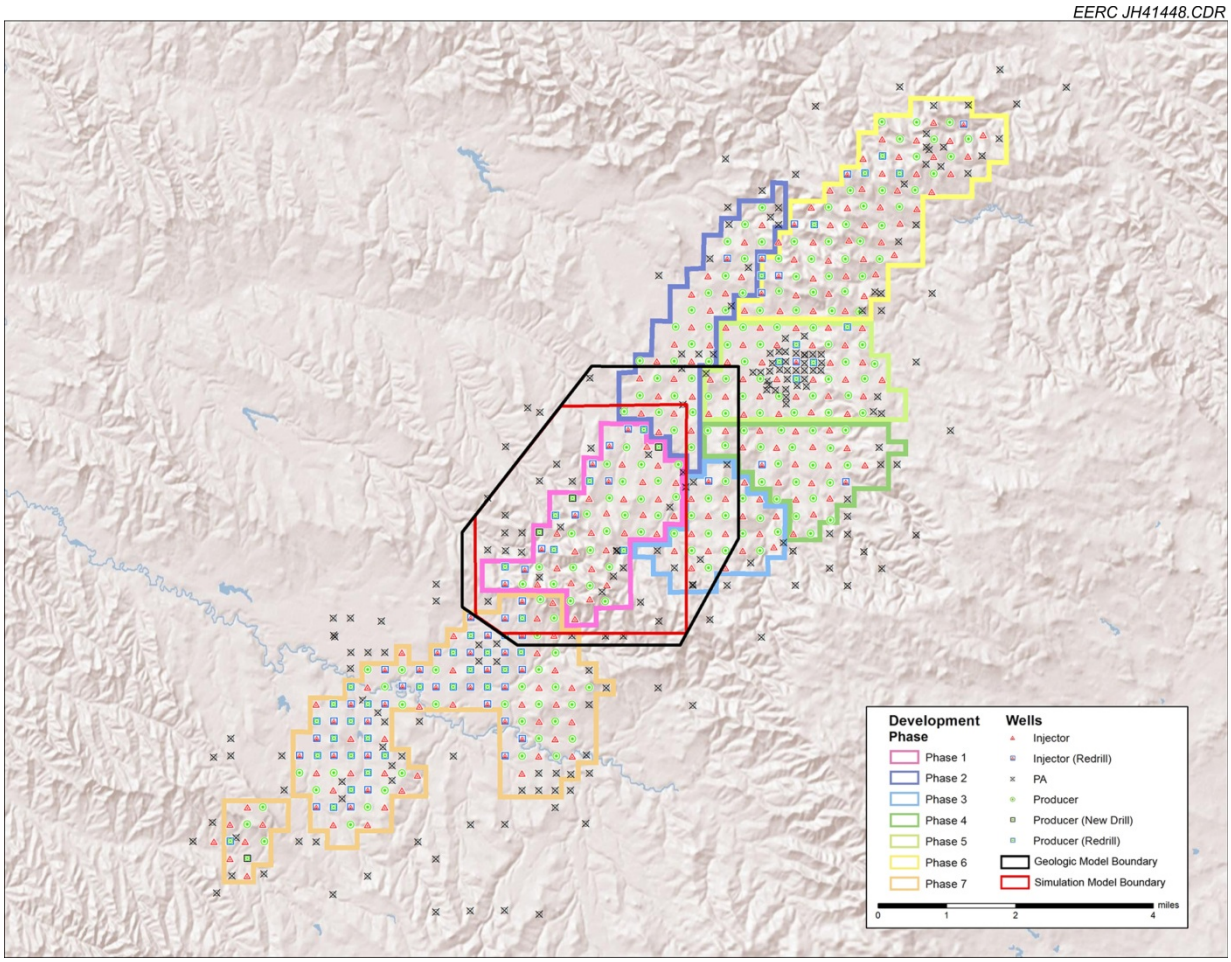


Figure 22. Map showing the geologic model boundary (black), the simulation model boundary (red), and their relation to the planned Bell Creek project development phases.

Petrophysical Evaluations for the Bell Creek Test Site

Full-diameter core was collected from well 0506 OW starting on December 21, 2011. Standard core analysis and special core analysis will be performed and utilized to supplement and update modeling efforts.

Sidewall Core Plugs

An assessment of the reservoir was conducted on sidewall core samples to evaluate the petrographic, petrophysical, and mineralogical variability within five intervals of interest in the oil-producing zones and overlying strata of the Bell Creek reservoir. Twelve of the 47 sidewall core samples collected during drilling of the Bell Creek 0506OW well were selected for this evaluation. One sample was from the Niobrara Formation (4111.0 ft), one was from the Mowry Formation (4400.0 ft), and the remaining samples, ranging in depth from 4508.75 to 4537.5 ft, represent the Coastal Plain, Bell Creek (BC) 10, BC20, and BC30 intervals of the Muddy Formation.

The mineralogical properties of the samples were analyzed using XRD, XRF, and thin-section grain analysis. XRD and XRF were used to quantify the bulk mineralogical and bulk chemical composition of the samples, respectively. Bulk sample mineralogy was also evaluated by thin-section interpretation. Four of the 12 samples were selected for a more detailed mineralogical assessment, including clay typing using XRD and mineralogical and textural evaluation and mapping using SEM coupled with EDS.

USGS Core Samples

In addition, rock samples from the U.S. Geological Survey (USGS) Core Library in Denver, Colorado, have been collected and are in the process of being tested. Samples selected are generally representative of the reservoir interval of the entire Bell Creek Field, and were collected with the intent of building upon the overall understanding of the fieldwide geologic setting. The overall testing will facilitate modeling and simulation activities and will aid in MVA planning and execution. Testing included the following:

- Thin-section creation and analysis
- XRD, XRF, and SEM analysis
- Dean–Stark cleaning and analysis extraction on core plugs
- Determination of porosity, bulk volume, and skeletal density on all samples
- Permeability-to-water measurements

CO_2 Exposure Studies

An evaluation of drill cuttings obtained during the drilling of the 0506 OW was conducted. The goal of this study is to provide geochemical and mineralogical data sets that could be used to better understand the potential reactions that may be anticipated if migration of CO_2 outside of the reservoir were to occur.

Drill cuttings collected from three different depths within the Hell Creek Formation, corresponding to depths at which groundwater was collected through the Bell Creek monitoring effort, were placed in glass vials, submerged with groundwater, and exposed to CO_2 for a period of 28 days in a pressurized vessel. To evaluate the potential effects of CO_2 exposure on the samples and corresponding groundwater, multiple analyses were conducted to evaluate potential chemical and mineralogical changes within the samples pre- and post-CO_2 exposure. Analytical techniques utilized include XRF, XRD, SEM, and wet-chemistry analyses. This work was conducted to better understand possible mineral dissolution/precipitation mechanisms and groundwater reaction kinetics in the groundwater zone overlying the Bell Creek oil and gas reservoir.

The key findings of all mineralogical, geochemical, and petrophysical assessments will be detailed in a value-added report(s).

Geochemical Evaluations and Modeling for the Bell Creek Test Site

Laboratory tests will be conducted on samples of the target injection formation and key sealing formations under reservoir conditions to assess the geochemical reactions anticipated to occur between the injected gas and the rocks and fluids of the reservoir and seal.

Geomechanical Rock Properties and Stress Regime Determination for the Bell Creek Test Site

The geomechanical properties of the reservoir and cap rock and stress regime in the area are examined to assess the mechanical integrity of the system and potential for rock fracturing. An in-depth review of available information on the stress regime and structural features in the area of the reservoir will be conducted to identify structures such as faults or dissolution areas. In October 2010, a geomechanical experimental design package (D87) describing the specific approaches and analytical techniques that will be used to conduct project activities was prepared.

Samples from full-diameter core collected at the 0506OW monitoring well were tested for bulk density, acoustic velocity, uniaxial strength, and triaxial strength. Peak strength (at failure) and elastic properties that will be measured will include, but are not necessarily limited to, confining stress at failure, peak strength, Young's modulus, Poisson's ratio, bulk modulus, and shear modulus. Selected samples may also be tested for residual friction measurements.

On the USGS samples, sample geometry was a problem. There was not enough material to make the correct size plug to test for mechanical properties. As a result, smaller samples were taken and routine core analysis was performed on them instead.

Assessment of Wellbore Integrity and Leakage Potential at the Bell Creek Test Site

It is not possible to determine the "exact" state of all wellbores within an oil field; consequently, both "real" field data and analytical or numerical simulations will be combined to quantify processes associated with the hydraulic integrity of the wells. A variety of activities focused on determining the potential for wellbore leakage in the Bell Creek oil field and the surrounding area continued in PY5.

Wellbore Integrity Data Collection Completed (M10, March 2012)

A technical team that includes Denbury, the EERC, and others is currently conducting a variety of activities to determine the baseline geologic characteristics of the subsurface environment and to assess the potential for out-of-zone fluid migrations, both through geologic strata and existing wellbores in the vicinity of the injection site. With respect to wellbore integrity, there are hundreds of existing wellbores in the Bell Creek oil field and many others in close proximity. Identification and examination of data related to drilling, completion, operation and, where applicable, plugging of these existing wellbores are necessary to determine the potential risk of out-of-zone fluid migration via wellbore and to guide monitoring and mitigation plans to identify and eliminate or minimize associated risks. To accomplish this goal, wellbore

data were compiled for the Bell Creek oil field and surrounding areas, available from both public databases and from nonpublic data provided by Denbury.

Collection of relevant wellbore data to aid in evaluating the potential for out-of-zone fluid migration via wellbores in the Bell Creek oil field and surrounding area was completed in December 2011. These activities included the collection and scanning of historical wellbore data files for the Bell Creek oil field and surrounding areas via Denbury archives and the Montana Board of Oil and Gas in Billings, Montana.

The data summary consisted of the following:

- 601 total wellbore files available from Denbury archives
- 120 total wellbore files scanned at the Montana Board of Oil and Gas

Task 5 – Well Drilling and Completion

The PCOR Partnership is working with Denbury, the operator of the Bell Creek oil field, to develop engineering designs for the installation of a dedicated monitoring and characterization well in the Bell Creek oil field. The feasibility of reentry into existing wells within the field which could provide additional downhole monitoring points is also under evaluation.

The development of operational plans for the injection and recycling of CO_2 over the duration of the project will also be conducted. Because the host site for the Bell Creek large-volume CO_2 injection test is an operational oil field already undergoing large-volume water injection activities, existing wells will be utilized for CO_2 injection, oil production, and monitoring. These wells are currently being reworked to accommodate long-term injection of supercritical CO_2. The EERC will provide technical support for these activities; however, the actual drilling, completion, and/or reconditioning of injection and production wells will be conducted by Denbury, while the EERC will be responsible for the drilling of a new monitoring well in the field, with support provided by Denbury. Activities under this task commenced October 1, 2010.

In September 2012, after reevaluation of scheduled activities associated with the Bell Creek test site, a deliverable and a milestone were changed. They include the following:

- D42, entitled Injection Experimental Design Package, was extended from September 30, 2012, to October 31, 2013.

- M27, entitled MVA Equipment Installation and Baseline MVA Activities Completed, was rescheduled from September 30, 2013, to May 31, 2013.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) included the following.

Monitoring Scheme Design

A monitoring experimental design package (D43) for the Bell Creek test site is under preparation. The following activities have taken place:

- Existing wells in the oil field will be considered and evaluated with respect to their potential use as monitoring wells for the Bell Creek test.

- If necessary, designs for the reconfiguration of existing wells into monitoring wells for the Bell Creek test will be developed.

- If necessary, locations for new wells will be identified and new monitoring wells designed for the Bell Creek test.

- Material needs and costs will be determined for the Bell Creek test.

MVA Work Plan

A work plan was prepared (and approved by Denbury) for the surface and near-surface MVA plan which included the following:

- Detailed maps with sample locations throughout the Bell Creek oil field
- Landowner maps (inputting the plats into GIS)
- Cost estimates
- A health and safety plan
- A detailed map of existing wells

Baseline MVA Activities

In March 2011, the baseline MVA was initiated. These activities can be broken into two main groups (surface and near-surface and deep MVA). In preparation for the activities, the EERC mobile office and lab trailers were located at the Bell Creek site in July 2011.

Surface and Near-Surface MVA Program

A baseline soil gas survey was performed over the entire Bell Creek oil field. Sampling began on November 1, 2011, and will include several repeat surveys to capture the seasonal variations in the soil gas content. A shallow groundwater-monitoring program is also being conducted, including shallow groundwater and surface water monitoring in selected groundwater wells and surface waters throughout the Bell Creek Field, focusing on the Phase 1 area. This baseline activity also began in November 2011 and will include several repeat surveys to capture seasonal variation in shallow groundwater and surface water compositions. A value-added preinjection surface water, groundwater, and soil gas baseline MVA sampling and analysis report including results is under preparation.

- Field Event 1 (held November 1–30, 2011):

- Completed the first surface water-, groundwater-, and soil gas-monitoring baseline sampling trip held November 1–10, 2011; 19 water samples were collected from eight surface waters, six stock, and five residential well locations. 96 soil gas samples were collected, which included soil gas samples at all injection and production well sites in the Phase 1 area and ten interspaced wells. Six injection and production wells were sampled per development phase in Phases 2, 3, 4, 5, and 7.

- Completed the second soil gas-sampling trip for Field Event 1 targeting plugged and abandoned (P&A) wells within and surrounding the Bell Creek oil field on November 28–30, 2011; 141 gas samples from 47 P&A wells were collected utilizing a three-spot pattern. In addition, six samples at injection and production well sites in Phase 6 as well as field blanks and repeat samples were also sampled.

- Field Event 2 (held April 24–27, 2012): Completed the second round of baseline water and soil gas sampling (Figure 23); 21 water samples were collected from eight surface waters, seven stock, and six residential well locations. Sampling was focused within and around the Phase 1 area, where a total of 130 samples were collected from the following well types: a) 81 injection and production, b) ten interspaced, and c) 13 P&A well sites. Analysis and interpretation of sampling data were initiated.

Figure 23. Collecting soil gas samples from a production pad in the Bell Creek Field.

- Field Event 3 (held June 16–22, 2012): Completed the third round of baseline water and soil gas sampling. Twenty-four water samples were collected from nine surface waters, seven stock wells, and eight residential well locations. Soil gas samples were sampled primarily within and around the Phase 1 area. A total of 251 samples were collected from the following well types: a) 96 injection and production, b) ten interspaced wells, and c) 50 P&A well sites. Five of the 50 sampled P&A wells were only able to be sampled in two directions instead of three.

- Field Event 4 (held August 6–9, 2012): Completed the fourth round of baseline water and soil gas sampling. Twenty-two water samples were collected from eight surface waters, seven stock wells, and seven residential well locations. Soil gas samples were collected primarily within and around the Phase 1 area. A total of 108 samples were collected from the following well types: a) 88 injection and production, b) ten interspaced wells, and c) four P&A well sites. One P&A well was sampled in only one direction (instead of three).

Deep MVA Program

Activities associated with a deep monitoring well were authorized in Modification 20 to the PCOR Partnership award in April 2011. The activities included drilling, testing, logging, and completing a deep monitoring well in the Phase 1 area of the Bell Creek Field to gather additional baseline data and a point in the field to monitor CO_2 as it moves between injectors and producers.

The spud date for the monitoring well was December 15, 2011 (Figure 24). Drilling, coring, logging, and PDM equipment installation at the Bell Creek observation well, 0506 OW, was completed on January 10, 2012. The specialty wellhead installed permits PDM technologies to be utilized in conjunction with other wireline-deployed downhole-monitoring technologies such as pulsed-neutron well logs and borehole seismic tools.

EERC staff supervised drilling activities at the Bell Creek site from December 9, 2011, through January 3, 2012. Drilling activities included the following:

- Mobilized Capstar Rig 314 beginning on December 9, 2011, to the Bell Creek site.
- Participated in a predrill meeting at the Bell Creek site on December 12, 2011, with Denbury, the EERC, and third-party service providers to discuss operational drilling logistics and safety.
- Initiated drilling of the observation well (0506 OW) on December 15, 2011.
- Targeted total depth of the surface hole was reached at 1010.0 ft on December 16, 2011.
- Completed cementing the surface casing.
- Drilled to 4400.0 ft and ran a gamma ray resistivity log to correlate core point depth.
- Drilled to 4446.0 ft and initiated coring operations.
- Recovered approximately 110 ft of drillstem core from the Bell Creek sands, Mowry shale, and Skull Creek shale.
- Drilled to 4855 ft.

Figure 24. Bell Creek Monitoring Well 0506 OW.

- Completed a seven-run logging, pressure-testing, and sidewall-coring program (recovered forty-seven 1.5-inch-diameter sidewall cores) on January 1, 2012.

The electrical installation of PDM equipment was conducted during the week of April 14–22, 2012. The system is fully operational and acquiring data (Figure 25).

Modification 23 to the Cooperative Agreement, received in June 2012, authorized additional funding for cost overruns associated with drilling, coring, logging, and completion of the deep monitoring well in the Bell Creek Field.

Additional activities completed in PY5 include the following:

- Submitted a survey on May 17, 2012, regarding the Bell Creek CO_2 Project to Victor Der, on behalf of the Global CCS Institute, for input into its annual CCS status report.

Task 6 – Infrastructure Development

This task facilitates the infrastructure planning required for CCS to be implemented on a wide-scale regional basis as well as the development of the specific infrastructure associated with the capture, dehydration, compression, and pipeline transportation of CO_2 from its source to a Bell Creek oil field for EOR. The infrastructure development for the Bell Creek test site will be performed by Denbury, with EERC personnel documenting the activities, interfacing with source facility engineers and vendors, and providing assistance as needed.

Figure 25. Qorex staff checking the functionality of the fiber optic distributed pressure/temperature data logger (leftmost open panel).

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) included the following.

Regional Infrastructure Planning

Efficient and cost-effective implementation of CCS on a wide scale will require a complete understanding of the PCOR Partnership region's infrastructure needs. It will also necessitate the development of a regional pipeline vision connecting various CO_2 sources with the most likely geologic storage opportunities. Activities include the following.

CO_2 Emission Sources

In September 2012, the annual update and quality assurance/quality control of the CO_2 emission source master data spreadsheet were completed (performed in conjunction with Task 1).

Capture Technology "Tree"

A value-added report entitled "Current Status of CO_2 Capture Technology Development and Application" was finalized in January 2011. This report provided a comprehensive overview of the current status of carbon capture technology development and application. The overview

covered technologies that apply to the three combustion platforms: precombustion, during combustion (oxycombustion and chemical-looping combustion), and postcombustion. The technologies reviewed fall into the categories of physical and chemical absorption; physical and chemical adsorption; mixed absorption and adsorption; oxygen-, hydrogen-, and CO_2-permeable membrane processes; cryogenic processes; mineralization; and photosynthesis and chemical and biochemical reduction processes as well as alternative mass transfer techniques. The document provided an overview of the technical basis for each separation method and information on nearly 100 technologies and/or research efforts. A summary table of the capture technologies was included in the report as an appendix.

Efforts to adapt the capture technologies table (from the appendix) for the DSS continued in PY5 (Figure 26). The PCOR Partnership capture technology tree will be maintained and updated on the partners-only Web site as a service to the PCOR Partnership partners. The tree provides basic technical information about various capture technologies as well as development status, source type applicability, and economic information (when available).

The interactive "tree" features the following information not included in the original appendix table:

- Short summaries of each of the technologies (Figure 27)
- Adobe files of the public information sources that best describe each of the technologies listed
- Image(s) associated with the technology

At the 2012 PCOR Partnership Annual Meeting held in Milwaukee, Wisconsin, the task lead demonstrated the interactive capture technology tree on the partners-only DSS test Web site as part of the "New for 2012" PCOR Partnership exhibit booth. It is estimated that the technology tree will be available to the partnership in PY6.

CO_2 Compression Technology Database

The majority of research on CCS has been on capture, injection, and subsequent monitoring of the CO_2 plume in a secure geologic setting, with little attention paid to compression or pipeline transport. In March 2011, a report entitled "Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities" was finalized. In PY5, a database of existing and emerging CO_2 compression technologies was under development and will ultimately be incorporated into the partners-only Web site. Also in PY5, the biennial update to the "Opportunities and Challenges" report was initiated. The update is due in PY6 (March 2013).

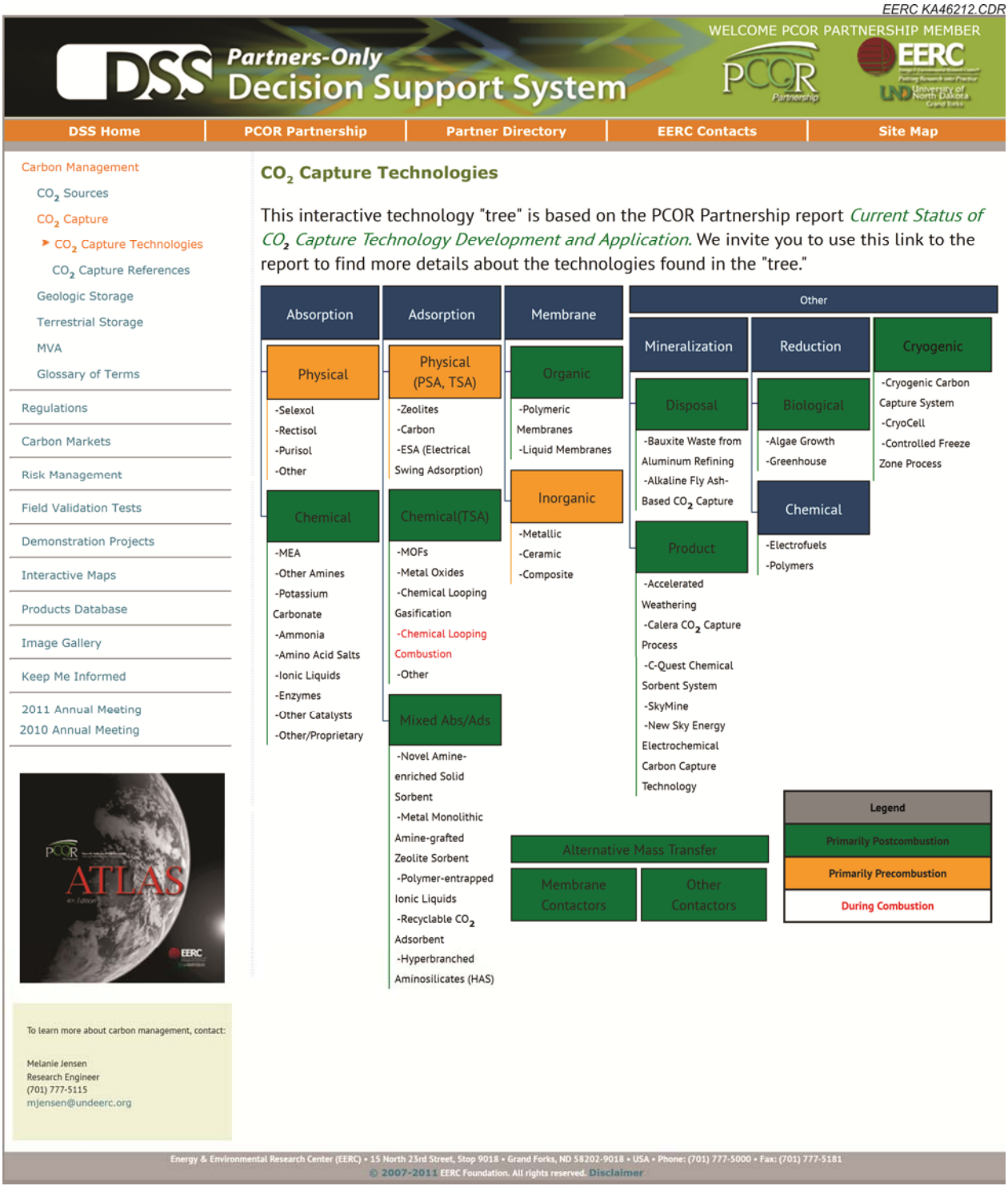


Figure 26. Draft interactive carbon capture technology tree planned for the partners-only Web site.

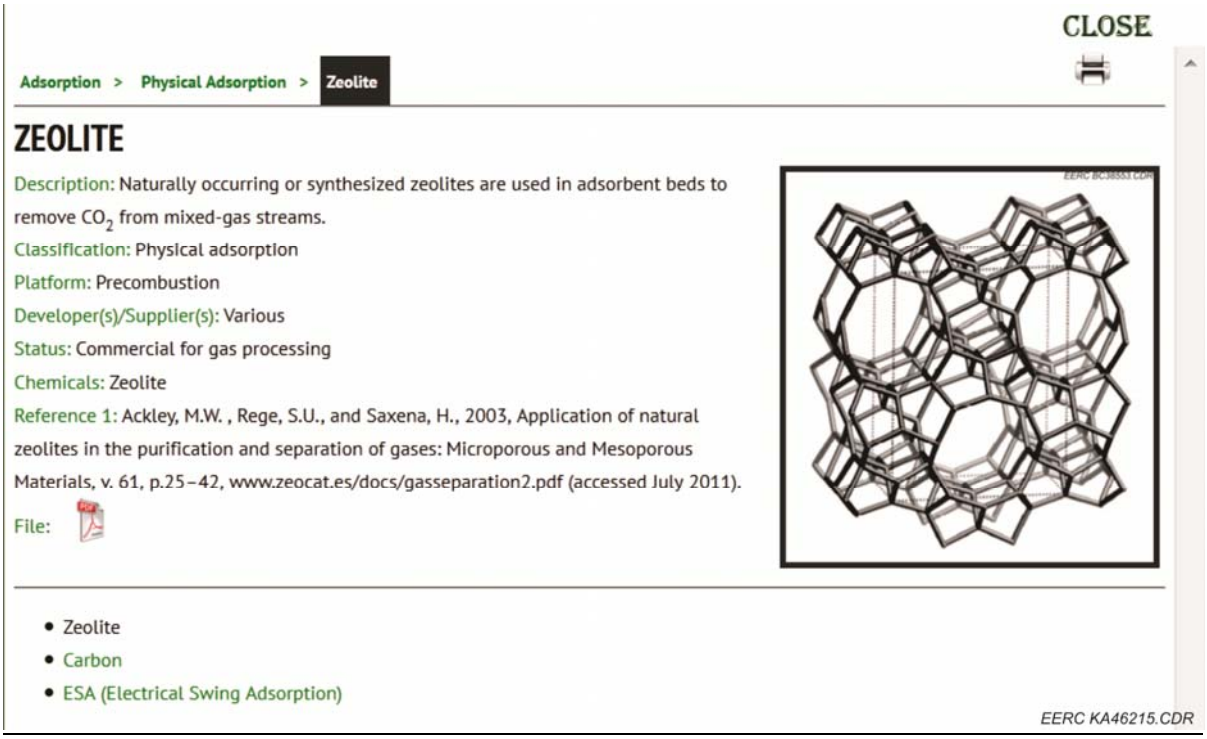


Figure 27. Draft short summary of one of the technologies featured on the interactive carbon capture technology tree planned for the partners-only Web site.

Phased Approach to Building a Hypothetical Pipeline Network for CO_2 Transportation During CCUS

Possible pipeline routes that could be used to implement CO_2 storage will be determined and updated as necessary. Potential phased routes will be developed beginning with the most likely initial routes followed by major trunk lines, then secondary lines, and finally feeder lines.

CCUS continues to receive considerable attention as a way to reduce U.S. CO_2 emissions. Enormous capital investment will be required to capture, compress, and transport the CO_2 to storage targets if the concept is deployed on a large scale. Unfortunately, many of the large CO_2 sources are not located near appropriate geologic storage areas, and it is likely that a national pipeline network would be needed to transport the CO_2 from the sources to the storage sinks. It is highly unlikely that a pipeline network would be built quickly; rather, it is more likely that a network would be built in stages or phases (Figure 28).

An effort was undertaken by the PCOR Partnership to estimate how a CO_2 pipeline network might be built in the PCOR Partnership region, over what time frame it might be built, and how much it might cost. The information was included in a report entitled “A Phased Approach to Building Pipeline Network for CO_2 Transportation During CCUS” (D84), prepared in June 2012 and showing hypothetical network development and estimated cost during each phase. It was found that a pipeline network of trunk lines roughly 6700 mi in total length could

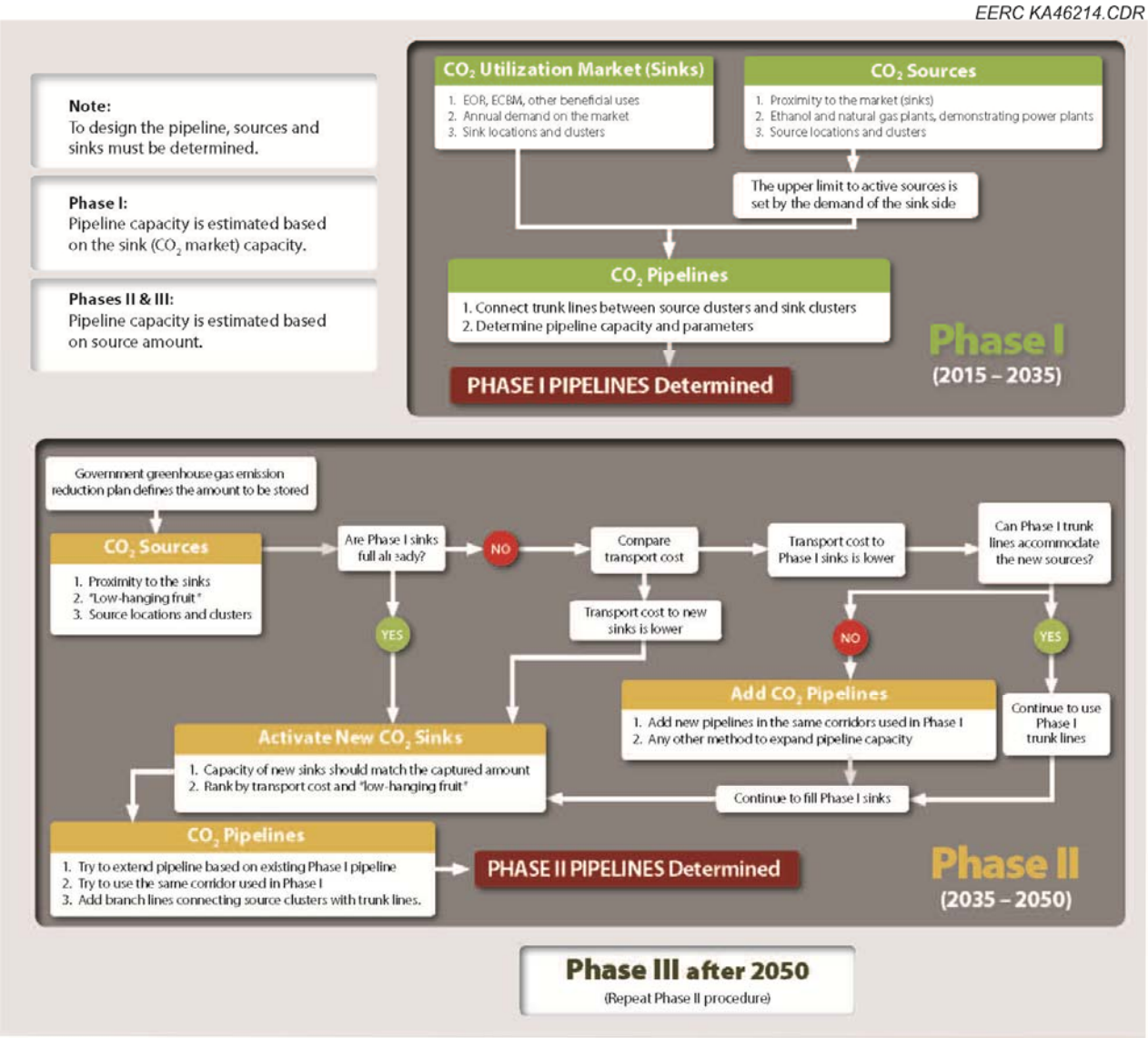


Figure 28. Flowchart summarizing pipeline network development methodology.

transport sufficient quantities of CO_2 such that the International Energy Agency (IEA) BLUE Map scenario could be met for the PCOR Partnership region by 2050. The IEA BLUE Map scenario represents a reduction in CO_2 emissions of 50% over 2005 levels by 2050. For the PCOR Partnership, this would be 444.7 Mtons/yr. The overall reduction for the PCOR Partnership region using this approach would be about 612.4 Mtons/yr by 2050.

Several abstracts based on the report on phased approach to building a hypothetical pipeline network for CO_2 transportation during CCUS were submitted and offers of acceptance received in PY5. They include the following:

- Accepted for a paper and poster for GHGT-11, scheduled for November 2012 in Kyoto, Japan.

- Accepted for a paper and presentation to the American Institute of Chemical Engineers (AIChE) National Meeting scheduled for October 30 – November 2, 2012, in Pittsburgh, Pennsylvania.

- Submitted as a peer-reviewed journal article for publication in *Energy & Fuels* (acceptance expected after December 2012).

RCSP Pipeline Atlas Working Group (PAWG)

DOE NETL was in the process of developing a national CO_2 pipeline atlas that served to highlight the state-of-the-science investigations on the development of CO_2 pipeline networks. The document was planned to emphasize ongoing pipeline studies, compare pipeline-modeling efforts, and provide visual representation of CO_2 source and sink locations throughout the United States and Canada. Similar to Atlas III, this document would serve as a public outreach tool and help readers understand the complexities associated with connecting emission sources to appropriate sinks. A working group was formed that consists of members from the RCSPs and NETL, and periodic teleconferences were planned, focusing on discussing the content and format of the pipeline atlas, finalizing the RCSP template, and establishing a timetable for pipeline atlas completion. The kickoff conference call of PAWG was held on October 21, 2009, and a second call was held in November 2009. No further action has been taken or calls scheduled since that time.

Bell Creek Test Site Infrastructure Development

Efforts are under way to identify, catalog, and quantitatively describe the infrastructure planning required for the cost-effective distribution of CO_2 within the Bell Creek oil field injection scheme. Technical challenges and their associated solutions will be documented for application to future large-scale injection projects.

Factors that may be evaluated include specifications for the CO_2 distribution system within the Bell Creek oil field, such as distribution pipe length, diameter, materials of construction, wall thickness, and inlet and outlet pressures; physical and chemical properties of the soil; flow rate meters; and corrosion monitoring, leak detection, and inspection and security systems. Other factors will be considered as appropriate.

The availability of technologies that can effectively and economically separate and capture the CO_2 from oil that is recovered as part of the EOR activities will be examined. Any methods development required for the Bell Creek demonstration will be performed in concert with the commercial partners, with EERC personnel interfacing with field engineers and vendors and providing assistance as needed.

An infrastructure development report will be prepared by the EERC describing the key elements of infrastructure that are required to cost-effectively distribute and inject CO_2 within an operating oil field as part of a simultaneous CCUS and EOR project. The report will contain the lessons learned from the Bell Creek demonstration project with respect to the capture efficiency

and cost, all aspects of CO_2 compression, and all aspects of pipeline transportation of the CO_2 to the injection site.

Ramgen Compression Technology Slipstream Test

The applicability of the Ramgen Power Systems compressor technology to CO_2 streams during CCUS will be evaluated. The EERC will partner with Ramgen Power Systems, LCC, to perform these activities. Initial subcontracted activities with Ramgen ended on September 30, 2009, with the submittal of a topical report on the preliminary design of advanced compression technology (D47). This report summarized Ramgen Power Systems activities relative to integration of the Ramgen compression technology with a power plant.

Since June 2011, and continuing throughout PY5, efforts have concentrated on gathering information about the well depth, diameter, downhole pressure, downhole temperature, etc., that will be needed to develop Bell Creek in-field compression specifications. The Ramgen compressor must be able to meet these specifications to be considered for implementation at the Bell Creek site.

In accordance with a reevaluation of task activities, a deliverable and a milestone were changed in September 2012. They include the following:

- D82, entitled Report – Issues Associated with Integration of Advanced Compression Technology into a CO_2 Storage Project, due September 30, 2012, has been deleted.

- M41, entitled Decision to Incorporate Ramgen Compression Technology into the Bell Creek Project, replaces D82, and is due January 31, 2014.

Presentations and Training

- Attended and presented at Nebraska Public Power District's (NPPD's) Power Summit on November 16, 2011, in Lincoln, Nebraska.

- Attended the 11th Annual CCUS Conference.

- The Task 6 graduate student was accepted to the Research Experience in Carbon Sequestration (RECS) Program, an intensive 10-day program put on by the Southeast Regional Carbon Sequestration Partnership and Southern Company and sponsored by DOE and DOE's Office of Fossil Energy and NETL. The program combines classroom instruction with group exercises, CCS site visits, and hands-on activities including geologic storage site characterization, CO_2 monitoring, modeling fluid flow in the subsurface, CCS deployment strategies, and communications training. Thirty students are selected each year to attend the RECS Program, which was held this year in June.

- Attended the NETL CO_2 Capture Technology Meeting held July 9–13, 2012, in Pittsburgh, Pennsylvania. Progress on development and testing of 67 capture technology projects was presented at the conference.

- Participated in an EERC-wide discussion of CO_2 capture activities that have been performed or are currently under way in-house. A summary of the PCOR Partnership Task 6 activities was presented.

- Hosted partner NPPD at a meeting on July 25, 2012. The discussion encompassed all projects performed at the EERC for NPPD as well as updates of PCOR Partnership activities, the PCOR Partnership Annual Meeting, and this task.

- Attended advanced Integrated Environmental Control Model (IECM) training to learn techniques that can be used to perform "what-if" scenarios with the model. In addition, learned that the booster station calculator within the pipeline module will be included in the next update of the model, which is expected to be available within the next 6 months.

Task 7 – CO_2 Procurement

This task documents CO_2 procurement procedures for CCS and EOR activities in the PCOR Partnership region. This task provides for EERC personnel to interface with commercial partners with respect to CO_2 procurement in the region as a means of documenting critical pathways for future projects.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) included the following activities.

Ongoing Monitoring and Assessment of the Commercial Issues of CO_2 Procurement

Through numerous discussions with industrial partners as well as Internet and other literature searches, efforts are ongoing to keep abreast of the various commercial issues associated with CO_2 procurement, such as contractual pricing mechanisms for CO_2, other potential customers, etc.

Procurement Plan and Agreement Facilitation

In 2009, Encore (now merged into Denbury) entered into a purchase and sale agreement to procure a CO_2 supply in the Bell Creek Field. Under the terms of the agreement, Denbury will purchase all of the volumes available from the Lost Cabin Gas Plant located in Fremont County, Wyoming. Initially, the volumes are estimated to be approximately 50 million cubic feet per day. The initial term of the contract is 15 years (source: www.allbusiness.com/company-activities-management/company-structures-ownership/12587712-1.html#ixzz1h5QRno9b, accessed December 2011).

Efforts continued in PY5 to document the nonproprietary business activities that are conducted to develop a CO_2 procurement plan and agreement for the Bell Creek project. A number of project meetings and project management discussions were held, specifically on

February 1 and 2, 2012; May 10 and 11, 2012; and June 25 and 26, 2012. In addition, the task lead attended a business dinner on December 4, 2011, and the 9th Annual Enhanced Oil Recovery Carbon Management Workshop on December 5–7, 2011, in Houston, Texas.

Task 8 – Transportation and Injection Operations

This task consists of monitoring and documenting commercial partner activities related to compression and transport of CO_2 via pipeline to the Bell Creek site, particularly as they relate to on-site injection. This task does not cover activities for the Fort Nelson site.

Activities and Results

CO_2 transport and injection will be conducted by Denbury as part of the commercial EOR project. The EERC will monitor and assess these operations.

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) included the following activities.

Monitoring and Assessment of Commercial Operations

To expand the task knowledge base, an EERC representative received training on the design of CO_2 injection and processing facilities for EOR at the PetroSkills "CO_2 Surface Facilities" training course (www.petroskills.com/courseDetails.aspx?courseID=532) held October 3–6, 2011, in Midland, Texas. Over 120 photographs were taken during the PetroSkills field trip to the Whiting CO_2 Recovery Plant near Wickett, Texas. The photos will be made available to the PCOR Partnership for use in presentations and reports. In addition, an overview of CO_2 phase behavior and types of CO_2-processing facilities used at oil fields was presented to interested PCOR Partnership and EERC staff members.

In February 2012, the task lead reviewed information about surface facilities and attended the surface facilities discussion with Denbury during its visit to the EERC. A list of questions for Denbury regarding the Bell Creek infrastructure was compiled in order to help streamline the collection of information. In June 2012, the task lead participated in project discussions with Denbury during its meeting at the EERC.

A short document summarizing the CO_2 processing at EOR surface facilities was initiated during the latter part of PY5.

Task 9 – Operational Monitoring and Modeling

This task develops data sets for the large-volume CO_2 injection tests that 1) verify that injection operations do not adversely impact human health or the environment and 2) validate the storage of CO_2 for the purpose of developing an understanding of the process for monetizing carbon credits.

In September 2012, after reevaluation, the following deliverables were deleted and will now be reported on in the quarterly progress reports:

- D71, entitled Bell Creek Test Site – Quarterly Summary of Operations, due October 31, 2013 – July 31, 2017.

- D72, entitled Fort Nelson Test Site – Quarterly Summary of Operations, due July 31, 2014 – July 31, 2017.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) include the following.

RCSP Sim/Risk Working Group

The Inter-Partnership Simulation and RA (Sim/Risk) Working Group consists of members from the RCSPs and NETL that hold periodic teleconferences and prepare content for a BPM on RA and simulation for geologic CO_2 storage. Activities in PY5 include the following:

- Participated in the Sim/Risk Working Group conference calls on October 25, 2011, and March 27, 2012.

Bell Creek Test Site

Site Characterization, Modeling, and Monitoring

In September 2011, a Site Characterization, Modeling, and Monitoring Report was completed. The report detailed the EERC's role at the Bell Creek test site as including support for site characterization, reservoir modeling and simulation, assessment of the subsurface technical risks, and assisting in the development of the MVA plan to address site risks. An integrated and iterative approach to site characterization, modeling and simulation, RA, and MVA will be utilized that will allow the program to be adaptive in nature, thereby maximizing utility of the overall program.

Bell Creek Risk Management Activities for the Bell Creek Test Site

An internal, preliminary risk register has been developed for the Bell Creek Demonstration project. Risk management activities for the Bell Creek project will use the same risk management framework that is being applied to the Fort Nelson site. The final processes and procedures that are ultimately used are evolving in order to seamlessly integrate with the risk processes and policies of the industry partner, Denbury.

Reservoir Modeling

Attributes such as injectivity, fluid production, and reservoir dynamics will be modeled using relevant software packages. The ultimate fate of the CO_2 over short-, intermediate-, long-, and extremely long term time frames will be predicted. A report on the specific results of the Bell Creek oil field simulations was prepared in August 2011 and was updated in August 2012 (D66). A 3-D static geologic model of the Phase 1 area (Version 1 model) was built to provide a geologic framework for performing dynamic simulations. The detailed geologic modeling has resulted in new interpretations regarding the total porosity, shale volume, effective porosity, permeability, reservoir thickness, and water saturation. The constructed geologic model was validated through history matching and was used with various predictive simulation scenarios.

Key results of PY5 simulation work include the following:

- A seven-component Peng–Robinson equation-of-state model was developed and tuned based on the available experimental pressure, volume, and temperature (PVT) data. The simulated results of standard PVT tests are in good agreement with the laboratory measurements. PVT simulations, based on current data, indicate that miscibility between CO_2 and initial Bell Creek recombined live crude oil will be attained with CO_2 gas at approximately 2800 psia.

- Qualitative investigation of the effect of solution gas-to-oil ratio (GOR) on MMP indicates that GOR could significantly affect MMP between injected CO_2 and crude oil in the depleted Bell Creek oil field, and current MMP could be closer to 2100 psia.

- To ensure the robustness of the developed EOS model, 1-D compositional simulation of the experimental slim-tube tests was performed. The MMP estimated from slim-tube simulation is lower than the MMP determined from the slim-tube experiment.

- A good agreement between the field history and simulation results (oil rate, water cut, and GOR) for the Phase 1 area model was observed.

- The estimated CO_2 storage capacity at 2 hydrocarbon pore volumes (HCPV) of continuous CO_2 injection is 5.3 million tons. In the case of 2 HCPV water alternating gas (WAG) (1:1) injection, CO_2 storage capacity is 3.00 million tons. In all the predictive simulation scenarios, the CO_2 plume is not expected to cross the Phase 1 area boundary. However, some of the CO_2 injected at down-structure wells appears to move into the adjacent downdip water leg.

- Reservoir simulation results suggest that alternately injecting slugs of CO_2 and water during the CO_2 injection program would be more effective than continuously injecting a single CO_2 slug. In the case of continuous CO_2 injection, the earliest CO_2 breakthrough at production wells appears to be in 6 months after the commencement of CO_2 injection. After 5.5 years of injection, injected CO_2 is expected to reach the newly drilled monitoring well. Overall, WAG injection slows down gas breakthrough and yields a better sweep efficiency, although the earliest CO_2 breakthrough at production wells

occurs in 3 months. In the WAG process, injected CO_2 is expected to reach the monitoring well after 6 years of injection.

Fort Nelson Test Site

Injection Zone Modeling

Attributes such as injectivity, fluid production, and reservoir dynamics have been modeled using relevant software packages. The ultimate capacity of the injection zone and the fate of the CO_2 over short-, intermediate-, long-, and extremely long-term time frames have been predicted. The EERC prepared a simulation report in August 2011 (D67) detailing the results of a simulation-based feasibility study conducted for the Fort Nelson site. The investigation scenarios included injection of 50 and 100 million tonnes of sour CO_2 over periods of 25 and 50 years, respectively. These injection scenarios were followed by 75 and 50 years of postinjection monitoring of the CO_2 plume for a total of 100 years. The potential for CO_2 plume migration to the adjacent gas pools (Clarke Lake Slave Points A and B) was also evaluated. Key conclusions were reached and recommendations made.

The initial Fort Nelson Test Site – Simulation Report was provided to Spectra via e-mail on September 2, 2011, and hand-delivered on a flash drive on September 13, 2011, during the PCOR Partnership Annual Meeting in Denver, Colorado. In PY5, SET was busy compiling data in order to make a successful business case for a commercial-scale CO_2 injection at Fort Nelson. Information provided in the 2011 simulation report was used to help document Spectra's injection initiative and move it through the Spectra approval and funding process.

To further confirm the evaluations presented in the initial study, the EERC recommended in August 2011 the following be included in any future modeling and simulation studies:

- Collection of more geologic information in the C-47-E area by means of drilling, coring, and logging of a new well, and acquisition of a new 3-D seismic survey over the predicted CO_2 plume footprint.

- Integration of various physical phenomena such as geochemical reactions, geomechanical behaviors, and thermal effects into the dynamic model to comprehensively understand the sink–seal system for more reliable predictions.

Spectra's review of the 2011 simulation report continues. Spectra and the EERC are constructing an updated geologic model; however, no new results were ready by July 2012, and no new numerical simulations have been performed since the last report.

Risk Management Activities for the Fort Nelson Test Site

A first-round RA, which addressed both nontechnical and technical project risks, was completed for the Fort Nelson CCS Project in the summer of 2009 (RA 2009). This effort was performed in conjunction with Spectra to ensure that the risk management process and policy will be applied throughout the life of the project. A second-round RA (RA 2010) was completed

that updated RA 2009 based on additional site data that were collected through the end of calendar year 2010. Plans are to update RA 2010 as more data are collected at the site and additional site modeling is performed. As part of each RA, MVA plans will be developed to ensure that the necessary data collection efforts are occurring during the lifetime of the project. In addition, preliminary mitigation plans will also be developed that reflect the results of the updated RAs. This iterative process will continue throughout the lifetime of the project as operating and MVA data are collected and evaluated.

Modeling Training Courses

- Modeling staff attended an "Introduction to CMOST" training course October 6 and 7, 2011, in Houston, Texas.

- Modeling staff attended a "CO_2 Sequestration with GEM" training course October 12 and 13, 2011, in Houston, Texas.

- Modeling staff attended a "Petrel Fracture Modeling" training course October 17 and 18, 2011, in Houston, Texas.

- Modeling staff participated in CMG simulation training entitled "2-Day History-Matching & Optimization (CMOST)" on June 5 and 6, 2012, in Houston, Texas.

- Modeling staff attended the ISRM–ARMA (International Society of Rock Mechanics–American Rock Mechanics Association) Workshop on Petroleum Geomechanics Testing and the 46th ARMA Symposium held June 22–26, 2012, in Chicago, Illinois.

- Modeling staff participated in Schlumberger OFM (Oil Field Manager) Fundamentals training on July 30 and 31, 2012, in Houston, Texas.

- Modeling staff participated in CMG simulation software training for PVT (WINPROP) modeling on August 22 and for CO_2 EOR modeling on August 23–24, 2012, in Houston, Texas.

- Modeling staff participated in various training courses at the 2012 TOUGH Symposium held September 17–22, 2012, at Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California. The TOUGH family of codes is a suite of computer programs for the simulation of multiphase fluid and heat flows in porous and fractured media.

Task 10 – Site Closure

This task was not active in BP4, PY5.

Task 11 – Postinjection Monitoring and Modeling

This task was not active in BP4, PY5.

Task 12 – Project Assessment

This task communicates and disseminates all Phase III activities detailed in annual progress reports. Reports summarize program progress, accomplishments, program recognition, travel, planned activities, and goals.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) include the following.

Assessment was conducted for the tasks during the period October 1, 2010 – September 30, 2011. A project assessment annual report (D57) was submitted on December 29, 2011.

Task 13 – Project Management

This task focuses on ensuring the overall success of the entire program by providing experienced management and leadership to each of the individual tasks and to the program as a whole. The PI and task leaders meet regularly to report the progress of their tasks and discuss any issues and corrective actions necessary. Task leaders are also responsible to provide the PI with written weekly updates. These updates include highlights (including trip reports), issues (i.e., budget, staffing, technical issues, etc.), opportunities, and travel plans. The monthly, quarterly, and yearly updates can be found on the PCOR Partnership DSS.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) include the following.

Progress Reports

Quarterly progress reports (D58), each including a milestone report (D59), were submitted to DOE and the PCOR Partnership partners 1 month after the end of each calendar quarter. In addition, monthly progress reports are submitted to the DOE NETL project manager shortly after month end and are also posted on the partners-only Web site. Informal weekly updates are e-mailed to the DOE NETL project manager.

DOE Contract (DE-FC26-05NT42592) Modifications

During PY5, two modifications to the contract were issued.

The EERC received DOE Cooperative Agreement Modifications 22 and 23 (dated April 30 and June 18, 2012, respectively). These modifications authorized the following:

- Incremental funding.

- Revised statement of project objectives (SOPO).
- Revised NEPA requirements.
- New SOPO Subtask 3.5 entitled “IOGCC Carbon Storage Task Force Activities.”
- Cost increase for SOPO Task 5.
- New SOPO Subtask 1.4 entitled “Collaboration with PTRC’s Aquistore Project” and related outreach and education activities at Subtasks 2.4, 2.7, and 2.8.
- Expanded SOPO Subtask 4.3.2 regarding Bell Creek site baseline geology determination.
- Expanded SOPO Subtask 16.2 regarding geologic characterization.
- Recognition of increased cost-share requirement.

Project Management Plan

In March 2011, an updated project management plan incorporating changes to the PCOR Partnership Program was submitted. Revisions to the plan are under way and will be submitted as necessary.

Annual Meetings

Regular project meetings (annual or as otherwise directed) will be held to ensure that project management and PCOR Partnership partner goals are being met. During PY5, the tenth partners meeting (the ninth meeting that included project results) was held.

The 2012 PCOR Partnership Annual Meeting was held September 12–13, 2012, in Milwaukee, Wisconsin, and attracted 84 attendees representing 51 organizations from 15 states, the District of Columbia, and two foreign countries (with Canada represented by four provinces) (Figure 29). The annual meeting provided an overview of carbon management topics, including new developments in CCUS strategies, updates on projects within the region and beyond, regulatory updates, and relevant products and services. The meeting also provided summaries of the PCOR Partnership’s completed and ongoing activities. In addition to the meeting, a workshop entitled “Core Analysis Basics” was held on September 11, 2012. The half-day workshop highlighted various core analysis methods and included a field trip to a nearby quarry.

RCSP Support

- The PCOR Partnership was asked to coordinate the RCSP WWG. This task began in January 2009 and is ongoing through 2017.

Figure 29. The 2012 annual meeting participants.

- Members of the GIS, Outreach, Water, and Sim/RA Working Groups took part in scheduled conference calls.

- An EERC staff member has served as Chairman of NAEWG's Subcommittee on CO_2 Storage Capacity Estimation, also known as the Methodology Subcommittee. This subcommittee discusses geologic storage capacity coefficients and the methodology for estimations. The data sharing of this group will lead to a solid foundation in the area of CO_2 capture and sequestration mapping and estimations in North America. This subcommittee coordinates its activities closely with NAEWG–NACAP. In PY5, EERC staff participated in NACAP-6 held January 30 – February 2, 2012, in Riviera Maya, Mexico (see also Task 1 for additional NACAP efforts).

- CCS is one of the topics that both the United States and Canada have expressed interest in to continue discussions. The U.S.–Canada Clean Energy Dialogue is led on the U.S. side by the DOE Office of Policy and International Affairs. At the request of DOE, the PCOR Partnership participated in the U.S.–Canada Clean Energy Dialogue 2 Bilateral Meeting on May 15 and at the MVA/MMV in Large-Scale CO_2 Injection Tests Workshop on May 16 and 17, both in Mobile, Alabama. Also at the request of DOE, the PCOR Partnership participated in the 2012 CCS Binational Conference, Building a Business Case for CCS: Maintaining the Momentum for Large-Scale Demonstration Projects held September 5, 2012, in Regina, Saskatchewan, and participated in the field trip on September 6, 2012, to Estevan, Saskatchewan, to tour Aquistore and the Boundary Dam projects.

DOE Fossil Energy Techlines

A draft DOE Fossil Energy Techline entitled "Regional Carbon Sequestration Partnership Releases New Atlas" was prepared in July 2012. This techline planned to report the availability of the 4th edition of the *PCOR Partnership Atlas*, offering the general public a "big picture" perspective of CCUS potential in the heartland of North America. In the 9 years since the PCOR Partnership first began, a wealth of new CCUS information has been discovered. The latest atlas

reflects this new knowledge and places it into the broad context of how these discoveries can contribute to making long-term CO_2 storage technologies safe, effective, and efficient. Unfortunately, DOE opted not to post this techline.

Annual Carbon Capture and Sequestration Conference

CCUS-11, sponsored by ExchangeMonitor Publications & Forums in partnership with NETL and DOE, attracted a crowd of nearly 600 participants from 22 countries to Pittsburgh April 30 – May 3, 2012.

Eight PCOR Partnership staff attended CCUS-11. Two oral presentations were given, two posters were presented, and staff participated in working group side meetings.

Annual Review Meeting

- Attended and presented one oral presentation and one poster presentation at the Carbon Storage Program Infrastructure Annual Review Meeting held November 15–17, 2011, in Pittsburgh, Pennsylvania.

- Attended and presented one oral presentation and four poster presentations at the DOE Carbon Storage R&D Project Review Meeting held August 21–23, 2012, in Pittsburgh, Pennsylvania.

PCOR Partnership Partners

The PCOR Partnership has significant support and participation from its partners. As of September 30, 2012, over 90 partners are supporting Phase III activities.

New partners added in PY5 include the following:

- BillyJack Consulting Inc. (October 2011)
- C12 Energy, Inc. (March 2012)
- Praxair Inc. (April 2012)

Task Leader Meetings

Approximately once a month, internal EERC meetings are held with all the task leaders, the PI/program manager, budget personnel, and support staff. These meetings are convened in order to share information, create time lines for the completion of products, and disseminate data.

Carbon Sequestration Leadership Forum

CSLF promotes collaborative research, development, and demonstration projects that reflect member priorities. CSLF may recognize collaborative projects that 1) facilitate the development of improved cost-effective technologies for the separation and capture of CO_2 for

transport and long-term safe storage, 2) make these technologies broadly available internationally, and 3) identify and address wider issues relating to CCS. The RCSP project, comprising the seven regional partnerships including the PCOR Partnership, was recognized by CSLF at its Berlin meeting in September 2005.

The PCOR Partnership's Fort Nelson CCS Project was granted CSLF recognition in October 2009 and is one of 35 such projects formally recognized. The PCOR Partnership has received project recognition for not only one project, but two projects. the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project received recognition in 2007. In PY5, the PCOR Partnership submitted progress updates for March and August 2012 to CSLF on both of its recognized projects.

In June 2012, PCOR Partnership management staff attended the CSLF Meetings of the Technical Group and Technical Workshop in Bergen, Norway.

Advisory Board Meetings

DOE required that an independent technical review be undertaken at the outset of the RCSP Phase III Program. DOE approached IEAGHG to undertake this review because of its extensive experience with CO_2 injection projects worldwide. To review the RCSP Program and its Phase III activities, IEAGHG appointed an independent international panel of experts. The experts were drawn from onshore CO_2 injection projects under way in Canada, Europe, and Australia. This initial review was conducted in March 2008.

DOE, through NETL, which manages the RCSP Initiative, required that a second independent review of the program should be undertaken in 2011. IEAGHG again organized this review, held March 14–17, 2011, at the Hilton Hotel in Arlington, Virginia. The 10-member panel comprised experts from Canada, the United Kingdom, Germany, Australia, Japan, and the United States. The PCOR Partnership gave an hour-long presentation, followed by 90 minutes of questions and answers, on March 15, 2011.

Following the presentation and question-and-answer session, the expert panel discussed its assessment of the PCOR Partnership's two demonstration-level projects and compiled comments and recommendations for each project. Based on these discussions and the written comments provided, IEAGHG prepared an evaluation for each project reviewed. The expert panel's evaluation of the PCOR Partnership's projects was received in June 2011.

A fundamental component of the NETL expert review process is that the recommendations identified by the expert panel are required to be addressed.

The panel's recommendations for both of the PCOR Partnership's projects, i.e., the Fort Nelson CCS Project and the Bell Creek Integrated CO_2 EOR and CO_2 Storage Project, included for consideration the "appointment of scientific and/or operational advisory boards or committees." When formal responses to the recommendations were submitted in August 2011, the EERC decided to establish a single-panel advisory board to provide scientific guidance on the entire PCOR Partnership Program, including both demonstration sites.

In September 2011, DOE issued a contract modification, No. 21, authorizing the creation of an advisory board under SOPO Task 13 – Project Management. DOE also agreed to fund meetings and associated expenses through September 30, 2015.

The inaugural Technical Advisory Board (TAB) meeting was held February 15 and 16, 2012, in San Diego, California, The first TAB comprises the following CCUS and EOR experts:

- Bill Jackson, BillyJack Consulting, Inc. (Chair)
- Stefan Bachu, Alberta Innovates – Technology Futures (AITF)
- Ray Hattenbach, Blue Strategies
- Lynn Helms, NDIC
- Mike Jones, Lignite Energy Council
- Steve Melzer, Melzer Consulting
- Tom Olle, Texas International Energy Partners
- Steve Whittaker, Global CCS Institute
- Neil Wildgust, PTRC

Although only five board members are required for a quorum, all nine appointed members were present and participated in the first meeting (Figure 30). After several presentations and discussions, the TAB commended the EERC and its PCOR Partnership for fostering and establishing numerous industrial partnerships. In addition, the *PCOR Partnership Atlas* was highlighted as an extremely valuable tool for identifying potential sources of CO_2 in the region.

Figure 30. PCOR Partnership 2012 TAB members. From left, Bill Jackson (Chair), Ray Hattenbach, Lynn Helms, Steve Whittaker, Neil Wildgust, Mike Jones, Tom Olle, Stefan Bachu, and Steve Melzer.

The next TAB meeting was scheduled as a breakfast meeting in conjunction with the PCOR Partnership Annual Meeting on September 12, 2012, in Milwaukee, Wisconsin. This meeting served as a brief recap of previously discussed items and recommendations and to finalize the report to be given to the entire partnership during the annual meeting.

Programmatic RMP

A preliminary risk analysis has been completed for the overall PCOR Partnership Program. A brainstorming meeting was held for all program task leaders, and the primary program risks were identified in four categories: technical, external, organizational, and project management. Some of the specific subcategories of risk factors within each of these four categories are presented in Table 4.

Each of the program risks was then assigned a probability of occurrence and a severity of impact associated with each occurrence. These values were used to rank the risks in a programmatic risk register, which will be reviewed to develop a set of risk management strategies for the program. In accordance with the overall risk management framework, this evaluation and ranking process will be repeated on a regular schedule to ensure that the identified risks are being properly managed and that no new risks have evolved within or outside of the program over time.

Task 14 – RCSP WWG Coordination

In order to investigate the relationship between water and CCS, members of the RCSPs have formed the WWG. Each RCSP has its own unique set of challenges related to water utilization and the implementation of CCS activity, and the WWG will help to address those concerns. The PCOR Partnership leads the RCSP WWG comprising appropriate stakeholders. The RCSP WWG was initiated in January 2009. The purpose of the WWG is to address the wide variety of concerns and opportunities at the nexus of carbon storage and water resources. Development of documents under this task is led by the EERC, with input from all WWG participants.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) include the following.

Table 4. Risk Categories for the PCOR Partnership Program

Technical	External	Organizational	Project Management
Complexity and Interfaces	Client/partner	Funding	Communication
Performances and Reliability	Market	Prioritization	Controlling
Quality	Regulatory	Project dependencies	Estimating
Requirements	Subcontractors and suppliers	Resources	Planning
Technology	Weather		

Monthly Conference Calls

A total of 34 monthly conference calls (Milestone [M] 23) have taken place since the inception of this task, ten of which were completed in PY5, as follows: October 26, 2011; November 30, 2011; January 19, 2012; February 28, 2012; March 27, 2012; May 31, 2012; June 28, 2012; July 24, 2012; August 30, 2012; and September 27, 2012. DOE NETL waived the requirement for conference calls during the months of December 2011 and April 2012. Minutes of the calls are submitted to the WWG the subsequent month following a call.

Status of the WWG

The WWG has completed the following items:

- Produced a white paper that identified a wide variety of nexus of water and CCS, provided a comprehensive review of related processes and concepts, and began identifying the various challenges and opportunities.

- Created a mission statement:

  "The mission of the RSCP WWG is to provide a resource of knowledge, insight, and guidance to stakeholders involved with water and water resources and their relationship to the developing technology of CCS."

- Developed a water and CCS fact sheet and general PowerPoint presentation that summarized work in the white paper, provided public outreach for the WWG, and have been distributed/presented at several conferences.

- Developed a technologies gap assessment document.

Annual Meetings

The fourth annual WWG meeting (M24) was held on May 3, 2012, in Pittsburgh, Pennsylvania, following the conclusion of the 11th Annual CCUS Conference. There were 14 attendees. The meeting agenda items included:

- An update on the combined water, energy, and carbon capture and storage modeling effort.

- An update on the IEAGHG investigation of extracted water for CCS.

- A discussion on the regional water initiative.

- A discussion of the outreach survey results and their relation to future WWG activities.

The meeting concluded following updates given by each of the participating regional partnerships.

Methodology Document

A methodology document (D79) to estimate the resource that might be available in different reservoirs will be generated as storage projects are developed. Because of the lack of water produced in current RCSP storage projects, on December 15, 2009, DOE waived the requirement for water resource estimation methodology documents originally due February 2010 and May 2011. The fact sheet submitted April 30, 2010, replaced the former. The technology gaps assessment document replaced the latter. In September 2012, DOE waived the requirement for the methodology documents originally due November 30, 2012 and November 30, 2015. New fact sheets will be created to replace these requirements (see section below). There are still two methodology documents required and they are due May 31, 2014, and May 31, 2017.

Challenges and Opportunities in the CCS and Water Nexus: A Technology Gap Assessment

In May 2010, the WWG members met to conduct a workshop on the challenges and opportunities associated with the CCS–water nexus. In September 2011, the document providing a technology gap assessment based on that workshop and subsequent discussions within the WWG was finalized. The document was approved in November 2011.

It was determined that there are many challenges related to maintaining the integrity of current water supplies, meeting new water demands, developing and managing new water resources, developing appropriate regulatory regimes, meeting stakeholder expectations, and controlling costs. In the future, the WWG expects to play an advisory role in the development of CCS technology, informing stakeholders of the various challenges they can expect to encounter with respect to water.

Fact Sheet Development

The WWG is using the technology gap assessment to develop outreach materials and engage in dialogue with stakeholder groups. Through this dialogue, the WWG can refine the list of challenges and opportunities and provide industry, government, and a variety of public groups with accurate, relevant, useful information as they each play a role in the development of CCS technology.

In December 2011, the WWG distributed a Stakeholder Group Outreach Survey. The results of the survey were compiled into a WWG Interest Inventory. The primary vehicle to address the WWG survey results is through the development of fact sheets.

In May 2012, the task lead distributed post-annual meeting materials to the WWG regarding the Water, Energy and Carbon Sequestration Simulation Model (WECSsim). This model and other efforts like it may be able to help the WWG determine the critical areas of need for CCS and water research.

In September 2012, a new deliverable, D99 entitled Water/CCS Nexus-Related Fact Sheet, was created. The WWG will determine the topics of three fact sheets respectively due March 31,

2013; October 31, 2013; and October 31, 2014. The first fact sheet will focus on water resource protection issues such as identifying leakage pathways, characterization efforts, and well design efforts leading to leakage pathway elimination or minimization. The WWG plans to determine the topics of the remaining two fact sheets during its monthly conference call in October 2012.

Best Practices Manual

A best practices document on the nexus of water and carbon storage activities will be assembled (D80) in BP5. This report will highlight the findings of the WWG and identify opportunities for water resource conservation and optimization in CCUS. The requirement for an interim report, originally due June 30, 2013, was eliminated in September 2012, and replaced with the requirement for another fact sheet (due October 2014).

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project

The Zama oil field in Alberta, Canada, was one of the geologic storage validation test sites during Phase II of the program. This project focused on the injection of acid gas into a partially depleted oil field for the simultaneous purpose of acid gas disposal, CO_2 storage, and EOR. Because of the useful results and positive outcomes developed throughout the Phase II project, the site owner, Apache Canada Ltd. (Apache), was amenable to participation in follow-on characterization efforts at the Zama site. Accordingly, in June 2010, DOE NETL approved furtherance of the work that was performed in the Zama oil field during Phase II. A new deliverable was added for this new work, i.e., D86, which will provide an updated regional technology implementation plan for the Zama project.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) include the following.

Apache was planning to divest certain conventional properties in Canada, including its EOR project in the Zama Field located in Alberta. However, during a meeting held in Calgary on June 22, 2011, Apache revealed that it will be retaining ownership and operation of the Zama Field. Because of Apache's corporate planning strategies and personnel redistribution, efforts to initiate the seismic profiles, logging suites, and MVA activities were delayed. They were originally slated to begin in January 2011.

In January 2012, EERC staff met with Apache staff in Calgary, Alberta, Canada. At that time they shared new information regarding Apache's planned operations for the Zama project. In response to Apache's shutdown of the Zama gas plant and stay on any future EOR operations, the EERC will not be able to complete the seismic profiles, logging suites, and MVA activities detailed in the 2011 SOPO. A revised scope of work was submitted for DOE approval. Modification 23 (June 2012) to the PCOR Partnership award included a revised SOPO that included revisions to Subtasks 15.3–15.5. These revisions are as follows.

Subtask 15.3 – Seismic Survey and Logging Suites was replaced by Subtask 15.3 – Data Acquisition at Additional Zama Pinnacles. The EERC, in collaboration with Apache and BillyJack Consulting, will gather additional data needed to conduct petrophysical, geostatistical, and geochemical/fracture modeling on pinnacles at the Zama oil field that are undergoing or have undergone CO_2 flood. These data may include the following:

- Well logs
- Well deviation data
- Raw 3-D seismic seg-y data at depth
- Drillstem test data
- Pressure transient study data or reports
- Any special core data or wireline logs that are available

Additionally, data needed for dynamic modeling of additional pinnacles will also be collected. These data may include the following:

- Well production and injection history
- Well files including completion, perforation, stimulation, and workover records
- Reservoir fluid PVT data
- Relative permeability and capillary pressure data
- Reservoir water chemistry
- Injection gas composition analysis
- Well wise production gas composition analysis
- Average reservoir pressure data
- Injection wellhead/BHP data
- Separator operating conditions
- Previous simulation reports
- Tracer data

Subtask 15.4 – MVA Activities was replaced by Subtask 15.4 – Static Model, History-Matching and Dynamic Simulation at Additional Zama Pinnacles. The EERC, in collaboration with Apache and BillyJack Consulting, will use newly acquired data to develop additional site-specific models at various pinnacles within the Zama oil field that are undergoing or have undergone CO_2 flood. These models will assist in the development of improved estimates of original oil in place (OOIP), recoverable reserves, and CO_2 storage capacity for each of those pinnacles which, in turn, will provide more insight regarding the overall potential for EOR in the Zama Field as a whole.

Subtask 15.5 – Acid Gas Phase Behavior and Rock Interactions Studies text was replaced by:

The EERC will conduct batch reactor experiments on Zama reservoir core samples. Samples will be exposed to pure CO_2 and acid gas and then analyzed for reaction products and chemical kinetic rates as well as morphology and SEM surface chemistry.

In September 2012, because of data acquisition delays, D86, entitled Updated Regional Technology Implementation Plan, was extended from April 30, 2013, to September 30, 2013. Also, a new milestone was created, namely, M40, entitled Further Characterization Completed, due September 30, 2013.

CSLF Recognition and Progress Reports

CSLF recognized the Zama Acid Gas EOR, CO_2 Sequestration, and Monitoring Project at its Paris meeting in March 2007. In PY5, the PCOR Partnership submitted to the CSLF Secretariat required project status reports on April 8, 2012, and September 6, 2012. Progress at the Zama site was reported as follows:

- Laboratory work was conducted with the following experiments:
  - Wellbore casing steels were exposed for durations of 15 and 28 days to mixtures of CO_2 and H_2S. Experiments were carried out at reservoir conditions analogous to Zama (2100 psi, 160°F). Analytical work was focused on deriving the nature of degradation observed.
  - Rock samples were also being exposed under the same conditions to determine if mineralogical changes are observed. Quantification of change was determined.
- Modeling and simulation have continued on the injection and production reservoir. A new site-specific model of the F Pool was developed to better understand the sweep efficiency of the reservoir and to calculate the overall storage potential of this and similar pinnacles in the field.
- Additional data were acquired and analyzed for input into new static geologic models.

As of May 2012, cumulative acid gas injected into the F Pool was 133,550 tons (CO_2 fraction – 93,485 tons), with net CO_2 stored of 40,357 tons.

- Approximately 74,202 incremental barrels of oil has been produced using this technique.
- At this time, Apache has shut down the gas plant, and plans for future oil field operations are ongoing.
- Improved static geologic models of additional pinnacles are being developed and detailed dynamic simulations of injection and production will be conducted. The goal of these efforts is to develop improved estimates of OOIP, recoverable reserves, and CO_2 storage capacity for each of those pinnacles that have yet to be extensively researched.

Cement Integrity Studies, Wellbores

There are a number of potential areas where casing/cement failure may be of concern with respect to the long-term (up to 500-year) containment of the stored injectate. To better understand the rate at which leakage could be expected to occur, the EERC conducted the following testing:

- Basic casing corrosion and failure testing: Testing was conducted to evaluate the rate of degradation of the casing in an acid gas/brine exposure environment.

- Dissolution rate of cement and increase in cement permeability testing: Testing was conducted to determine the rate of degradation of cement (measured by an increase in the effective permeability) when exposed to brine or brine plus acid gas mixtures.

Static and Dynamic Modeling

A new site-specific model of the F Pool target injection zone was developed. This model has provided Apache with the necessary information required to determine sweep efficiency, wellbore placement, and further understanding of the heterogeneity of the reef structure.

The preliminary static geologic model was developed utilizing as much as 50 years' worth of reservoir-specific data (core analyses, wireline logs, facies distributions of the pinnacles, etc.) provided by Apache. In PY5, the EERC initiated the process of modifying the F-Pool static geologic model based on a combination of history-matching results and a revised geological interpretation of the pinnacle reef morphology. The newly built site-specific Zama F Pool static geologic model was used to perform detailed history matching and future CO_2 EOR and CO_2 storage predictions.

Data Acquisition at Additional Zama Pinnacles

The EERC will gather additional data needed to conduct petrophysical, geostatistical, and geochemical/fracture modeling on pinnacles at Zama oil field that are undergoing or have undergone CO_2 flood.

In PY5, the EERC imported Apache's updated production and injection data (through May 2012) to the dynamic model. It then compiled data for updated injection and production volumes. Apache also provided reservoir operational data and geologic characterization data for four additional pinnacles.

One of the equiprobable static realizations (P10 OOIP) was chosen for dynamic modeling. A detailed history matching was performed to match cumulative production (oil, gas, and water) and gas injection volumes and reservoir pressure response through May 2012. The individual well performance was also history-matched. Further predictive simulations are in progress for evaluating the future CO_2 EOR and CO_2 storage potentials of the Zama F Pool.

Static Model, History Matching, and Dynamic Simulation at Additional Zama Pinnacles

The EERC will use newly acquired data to develop additional site-specific models at various pinnacles within the Zama oil field that are undergoing or have undergone CO_2 flood. This work began on September 1, 2012, and included data compilation for building the static and dynamic models for additional pinnacles.

Acid Gas Phase Behavior and Rock Interactions Studies

The EERC conducted batch reactor experiments on Zama reservoir core samples. Samples were exposed to pure CO_2 and acid gas and then analyzed for reaction products and chemical kinetic rates as well as morphology and SEM surface chemistry.

Abstracts and Presentations

- An abstract on dynamic modeling was accepted for poster presentation at GHGT-11.

- Presented a poster entitled "Using Multiple-Point Statistics for Conditioning a Zama Pinnacle Reef Facies Model to Production History" at the American Association of Petroleum Geologists (AAPG) Annual Meeting in Long Beach, California, April 22–25, 2012.

- Staff presented a poster entitled "A Simulation Study of Simultaneous Acid Gas EOR and CO_2 Storage at Apache's Zama F Pool" on August 21, 2012, at the DOE Carbon Storage R&D Project Review Meeting held in Pittsburgh, Pennsylvania.

Task 16 – Basal Cambrian System Characterization

As part of the ongoing effort to characterize the northern Great Plains region of North America, a 3-year project is under way with a goal of determining the potential for geologic storage of CO_2 in rock formations of the basal Cambrian system. This sequence of saline formations is continuous throughout much of the PCOR Partnership region and underlies many of the area's large point sources of CO_2. The basal Cambrian system represents a regionally significant target for CCS but is an area that has not previously been systematically evaluated with respect to CO_2 storage resource.

Because the basal Cambrian system occurs in large parts of both the United States and Canada, this project is under way by the EERC in cooperation with AITF as a binational effort. The EERC will work closely with key partners in the United States to evaluate the American portion of the basal Cambrian system. AITF is leading a multiprovince team to conduct a similar evaluation for the Canadian portion of this system.

Activities and Results

Accomplishments during BP4, PY5 (October 1, 2011 – September 30, 2012) include the following.

CO_2 Source Characterization

In September 2011, a value-added report was prepared entitled "Overview of U.S. Sources that Overlay the Basal Cambrian Deadwood Formation." The stationary sources emitting more than 100,000 tonnes CO_2/year that overlay the U.S. portion of the basal Cambrian Deadwood Formation were identified. Sources that met the minimum emission limit included electricity generation, ethanol production, cement/clinker production, lime production, fuel/chemical production, petroleum refining, and institutional heat/power facilities.

Geological Characterization

Significant effort has been devoted to fully understanding the geological and hydrogeological character of the basal Cambrian system. The report entitled "Geological Characterization of the Basal Cambrian System in the Williston Basin" (D91) was prepared in February 2012.

At the base of the sedimentary succession in the Williston and Alberta Basins of the northern Great Plains–Prairie region of North America is a saline system composed of variable lithology which includes a variety of clastic and carbonate facies deposited across a range of depositional environments. This system lies directly on top of igneous and metamorphic basement rocks and is largely contained beneath sealing formations that include shales and tight carbonates. These Middle Cambrian- to Lower Silurian-aged rocks encompass 1.34 million km^2 and extend from west-central Alberta into Saskatchewan and southwestern Manitoba and then south into Montana, North Dakota, and South Dakota to form an extensive saline system generally devoid of hydrocarbon resources.

The initial phase of this project focused on delineating and characterizing separately the Canadian and U.S. portions of the Cambro–Ordovician Saline System (COSS). D91 describes the effort to characterize the U.S. portion of the region and how the data from the two countries were brought together into a single geologic model. The completed 2-D model incorporates the geologic data collected in the baseline characterization effort and distributes the various rock properties throughout the study region through geostatistical methods. Data regarding depth, thickness, and porosity were distilled to produce components needed to compute the CO_2 storage resource of this saline system following the E_{saline} formula detailed by the DOE methodology.

Frequent and unfortunate by-products of the individual efforts conducted in this central interior portion of North America are evaluations and related maps that show a "fault line" (discontinuity) at the U.S.–Canada border. Evaluating the capacity and effects of CO_2 storage in the Canadian or U.S. portions of the Williston Basin should not be done in isolation. The regional geology of sedimentary basins is not influenced by political boundaries. To ensure that an international "fault line" was not part of the final product, a significant part of the effort was

to match the work done on the U.S. side of the study region with the data sets generated by AITF for the Canadian side. A diffusive aggregation method was successfully employed near the U.S.–Canadian border to form a seamless CO_2 2-D model and CO_2 storage distribution map for the entire COSS international study region (Figure 31).

The CO_2 storage resource derived from the resulting 2-D model for the U.S. portion of the COSS was determined to be 28 Gt at the P50 probability level. When added to the 85 Gt of storage resource determined from the Canadian effort, this results in a combined CO_2 storage resource of 113 Gt. This work also provides the groundwork for the development of a massive 3-D geologic model encompassing the entire study area.

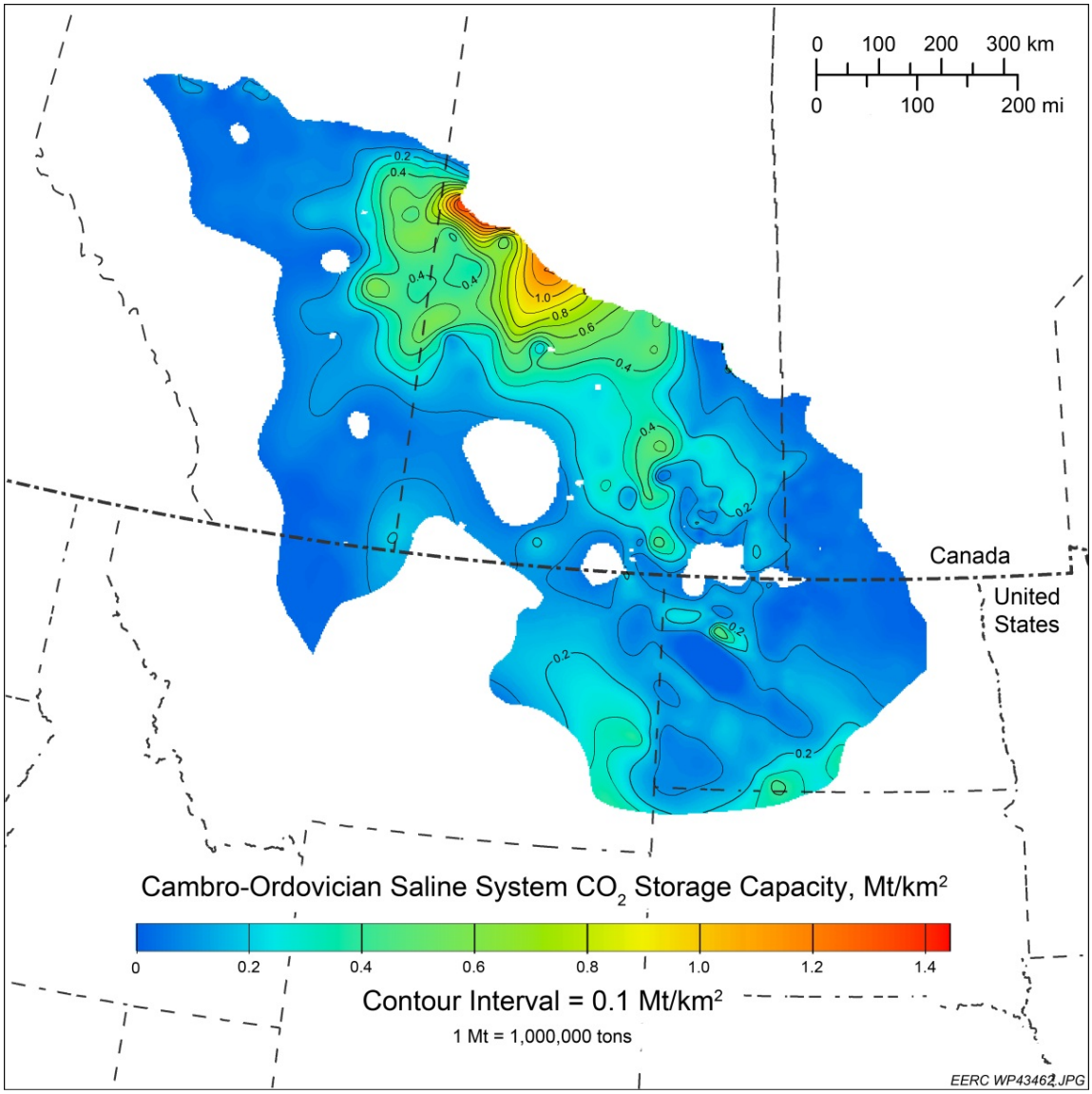


Figure 31. Final seamless CO_2 storage distribution map for the entire COSS.

Storage Capacity Evaluation

A regional estimate will be developed of the available storage capacity within the basal Cambrian system and the effects of potential large-scale multiple-point injection scenarios. The following activities have been initiated:

- Evaluation of the volumetric storage capacity of the system based on system geometry, pore space, CO_2 density, and storage efficiency coefficients.

- Evaluation of the dynamic storage capacity of the system in terms of injection of CO_2 from possible injection scenarios.

- A determination of the effects of brine displacement on the overall storage capacity and pressure regime will be conducted.

Storage Integrity

An assessment of the general overall integrity of the basal Cambrian system will be conducted. It is necessary that the characterization and storage capacity evaluation be under way in order to begin the assessment. The start date for the storage integrity assessment initiation was delayed until August 2011. In PY5, dynamic simulations and laboratory activities were well under way, including the following:

- Evaluation of the geochemical effects of CO_2 storage in the system, including that of impurities contained in the injection stream where known.

- Evaluation of potential geochemical effects of the injected CO_2 and associated impurities on cap rock and well integrity.

Joint U.S.–Canada Basal Aquifer Project, A Binational Effort

Members of the steering and technical committees include the following:

<u>United States</u>
- DOE NETL
- EERC
- LBNL
- Princeton University

<u>Canada</u>
- AITF
- Alberta Innovates – Energy & Environmental Solutions
- CANMETenergy
- Manitoba Innovation, Energy, and Mines
- Manitoba Water Stewardship
- Natural Resources Canada
- PTRC
- Saskatchewan Energy & Resources
- TOTAL E&P Ltd.

The following project meetings were held in PY5:

- November 16, 2011: Technical Committee Meeting held in conjunction with the Carbon Storage Program Infrastructure Annual Review Meeting in Pittsburgh, Pennsylvania.

- April 17–19, 2012: Attended and presented at the U.S.–Canada project meeting in Regina, Saskatchewan, Canada.

- September 13, 2012 – Technical Committee Meeting held in conjunction with the PCOR Partnership Annual Meeting in Milwaukee, Wisconsin.

Presentations

- Prepared a poster entitled "CO_2 Storage Characterization of the Basal Aquifer System in the Northern Great Plains – Prairie Region of North America" for presentation at the Carbon Storage Program Infrastructure Annual Review Meeting held November 16, 2011, in Pittsburgh, Pennsylvania.

- Prepared a poster presentation entitled "CO_2 Storage of the Cambro–Ordovician Saline System in the Northern Great Plains–Prairie Regional of North America" on August 22, 2012, at the DOE NETL Carbon Storage R&D Project Review meeting in Pittsburgh, Pennsylvania.

- Delivered an oral presentation entitled "PCOR Partnership Update on the Basal Cambrian Saline System Project" at the PCOR Partnership Annual Meeting in Milwaukee, Wisconsin, on September 13, 2012.

COST STATUS

The currently approved budget for Phase III is shown in Table 5.

On September 30, 2012, the PCOR Partnership completed its fifth year of BP4 activities (PY5, October 1, 2011 – September 30, 2012). Actual cash expenditures of DOE and nonfederal sources, as well as noncash cost share reported through September 30, 2012, are listed in Table 6.

SCHEDULE STATUS

Table 7 contains all of the Phase III deliverables, milestones, and submission dates for the reporting period. Tables 8 and 9 provide Gantt charts for BP4, including the reporting period (BP4, PY5) and the next program year.

Table 5. PCOR Partnership Phase III Budget as of Mod 23

	BP3 Year 1 – Year 2 10/1/07 – 9/30/09		BP4 Year 3 – Year 8 10/1/09 – 9/30/15		BP5 Year 9 – Year 10 10/1/015 – 9/30/17		Total	
DOE Share	$4,209,149	54.59%	$58,400,697	66.48%	$9,668,307	80.00%	$72,278,153	67.15%
Nonfederal Cost Share								
Cash*	$887,428		$2,411,971		$0		$3,299,399	
Noncash	$2,613,890		$27,034,759		$2,417,076		$32,065,725	
Total Nonfederal Cost Share	$3,501,318	45.41%	$29,446,730	33.52%	$2,417,076	20.00%	$35,365,124	32.85%
Total	$7,710,467	100.00%	$87,847,427	100.00%	$12,085,383	100.00%	$107,643,277	100.00%

* Cash as recognized by DOE.

Table 6. BP4 Funding and Actual Costs as of September 30, 2012

Organization	Approved Budget, $	Actual Costs Incurred, $
DOE Share – Cash	58,400,697	24,386,383
Nonfederal Share – Cash	2,411,971	1,918,073
Nonfederal Share – In-Kind	27,034,759	23,729,890
Total	87,847,427	50,034,346

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones

Title/Description	Due Date	Actual Completion Date
Year 1 – Quarter 1 (October–December 2007)		
D37: Task 4 – Fort Nelson Test Site – Geological Characterization Experimental Design Package	12/31/07	12/28/07
D63: Task 13 – Project Management Plan	12/31/07	12/28/07
M17: Task 4 – Fort Nelson Test Site Selected	12/31/07	12/28/07
Year 1 – Quarter 2 (January–March 2008)		
D38: Task 4 – Fort Nelson Test Site – Geomechanical Experimental Design Package	1/31/08	1/31/08
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/08	1/31/08
D11: Task 2 – Outreach Plan	3/31/08	3/31/08
D27: Task 3 – Environmental Questionnaire – Fort Nelson Test Site	3/31/08	4/02/08
D30: Task 4 – Williston Basin Test Site – Geomechanical Experimental Design Package	3/31/08	3/31/08
M1: Task 1 – Three Target Areas Selected for Detailed Characterization	3/31/08	3/20/08
M18: Task 4 – Fort Nelson Test Site Geochemical Work Initiated	3/31/08	3/19/08
Year 1 – Quarter 3 (April–June 2008)		
D14: Task 2 – General Phase III Fact Sheet	4/30/08	4/30/08
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/08	4/30/08
D17: Task 2 – General Phase III Information PowerPoint Presentation	5/30/08	5/30/08
M3: Task 3 – Start Environmental Questionnaire for Williston Basin Test Site	6/30/08	6/27/08
M6: Task 4 – Williston Basin Test Site Geochemical Work Initiated	6/30/08	6/30/08
M7: Task 4 – Williston Basin Test Site Geological Characterization Data Collection Initiated	6/30/08	6/30/08
Year 1 – Quarter 4 (July–September 2008)		
D12: Task 2 – Demonstration Web Pages on the Public Site	7/31/08	7/31/08
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/08	7/31/08
D1: Task 1 – Review of Source Attributes	9/30/08	9/26/08
M2: Task 1 – Demonstration Project Reporting System (DPRS) Prototype Completed	9/30/08	9/26/08
Year 2 – Quarter 1 (October–December 2008)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/08	10/31/08
D20: Task 2 – Documentary Support to PowerPoint and Web Site	12/31/08	12/31/08
D57: Task 12 – Project Assessment Annual Report	12/31/08	12/31/08

Continued . . .

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 2 – Quarter 2 (January–March 2009)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/09	1/30/09
M21: Task 14 – Outline of White Paper on Nexus of CO_2 Capture and Sequestration (CCS) and Water, Part Subtask 14.2 – White Paper on Nexus of CCS and Water	2/28/09	2/27/09
D24: Task 2 – PCOR Partnership Region Sequestration General Poster	3/31/09	3/31/09
Year 2 – Quarter 3 (April–June 2009)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/09	4/30/09
M23: Task 14 – Monthly WWG Conference Call Held	4/30/09	4/15/09
D2: Task 1 – First Target Area Completed	5/29/09	5/29/09
M23: Task 14 – Monthly WWG Conference Call Held	5/29/09	5/29/09
D16: Task 2 – Fort Nelson Test Site Fact Sheet	5/29/09	5/29/09
M24: Task 14 – WWG Annual Meeting Held	5/31/09	5/07/09
M23: Task 14 – Monthly WWG Conference Call Held	6/30/09	6/25/09
Year 2 – Quarter 4 (July–September 2009)		
M23: Task 14 – Monthly WWG Conference Call Held	N/A	Not required
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation	7/31/09	7/31/09
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/09	7/31/09
M22: Task 14 – Draft White Paper – Nexus of CCS and Water Available for Comments	8/17/09	8/18/09 (DOE) 8/21/09 (WWG)
M23: Task 14 – Monthly WWG Conference Call Held	8/31/09	8/25/09
D1: Task 1 – Review of Source Attributes	9/30/09	9/25/09
D3: Task 1 – Permitting Review – One State and One Province	9/30/09	9/30/09
D9: Task 1 – Updated DSS	9/30/09	9/29/09
D47: Task 6 – Report on the Preliminary Design of Advanced Compression Technology	9/30/09	9/30/09
D77: Task 13 – Risk Management Plan Outline	9/30/09	9/18/09
M4: Task 4 – Bell Creek Test Site Selected	9/30/09	9/30/09
M5: Task 4 – Bell Creek Test Site – Data Collection Initiated	9/30/09	9/30/09
M23: Task 14 – Monthly WWG Conference Call Held	9/30/09	9/22/09

Continued . . .

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 3 – Quarter 1 (October–December 2009)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/30/09	11/02/09
D78: Task 14 – Final White Paper on the Nexus of CCS and Water	10/30/09	10/28/09
M23: Task 14 – Monthly WWG Conference Call Held	10/31/09	10/26/09
M23: Task 14 – Monthly WWG Conference Call Held	11/30/09	11/16/09
D57: Task 12 – Project Assessment Annual Report	12/31/09	12/31/09
M23: Task 14 – Monthly WWG Conference Call Held	12/31/09	Waived by DOE
Year 3 – Quarter 2 (January–March 2010)		
D13: Task 2 – Public Site Updates	1/15/10	1/15/10
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/10	1/29/10
M23: Task 14 – Monthly WWG Conference Call Held	1/31/10	1/6/10
D79: Task 14 – Water Resource Estimation Methodology Document	2/28/10	Waived by DOE
M23: Task 14 – Monthly WWG Conference Call Held	2/28/10	2/25/10
D11: Task 2 – Outreach Plan	3/31/10	3/31/10
M23: Task 14 – Monthly WWG Conference Call Held	3/31/10	3/23/10
Year 3 – Quarter 3 (April–June 2010)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/10	4/30/10
M23: Task 14 – Monthly WWG Conference Call Held	4/30/10	4/28/10
M23: Task 14 – Monthly WWG Conference Call Held	5/31/10	5/13/10
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	6/30/10	6/30/10
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (update)	6/30/10	6/29/10
M23: Task 14 – Monthly WWG Conference Call Held	6/30/10	6/23/10
M24: Task 14 – WWG Annual Meeting Held	6/30/10	5/13/10
Year 3 – Quarter 4 (July–September 2010)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/10	7/29/10
M23: Task 14 – Monthly WWG Conference Call Held	7/31/10	7/28/10
M23: Task 14 – Monthly WWG Conference Call Held	8/31/10	8/31/10
D1: Task 1 – Review of Source Attributes	9/30/10	9/20/10
D52: Task 9 – Fort Nelson Test Site – Site Characterization, Modeling, and Monitoring Plan	9/30/10	9/30/10
M9: Task 4 – Bell Creek Test Site Geologic Model Development Initiated	9/30/10	9/30/10
M23: Task 14 – Monthly WWG Conference Call Held	9/30/10	Waived by DOE

Continued . . .

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 4 – Quarter 1 (October–December 2010)		
D87: Task 4 – Bell Creek Test Site – Geomechanical Experimental Design Package	10/30/10	10/29/10
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/10	10/29/10
M23: Task 14 – Monthly WWG Conference Call Held	10/31/10	10/26/10
M23: Task 14 – Monthly WWG Conference Call Held	11/30/10	Waived by DOE
D57: Task 12 – Project Assessment Annual Report	12/31/10	12/23/10
M23: Task 14 – Monthly WWG Conference Call Held	12/31/10	12/13/10
Year 4 – Quarter 2 (January–March 2011)		
M8: Task 4 – Bell Creek Test Site Wellbore Leakage Data Collection Initiated	1/15/11	1/14/11
D31: Task 4 – Bell Creek Test Site – Geological Characterization Experimental Design Package	1/31/11	1/27/11
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/11	1/31/11
M23: Task 14 – Monthly WWG Conference Call Held	1/31/11	1/19/11
M28: Task 4 – Bell Creek Geological Experimental Design Package Completed	1/31/11	1/27/11
D15: Task 2 – Bell Creek Test Site Fact Sheet	2/28/11	2/28/11
M23: Task 14 – Monthly WWG Conference Call Held	2/28/11	Waived by DOE
D10: Task 1 – Demonstration Project Reporting System Update	3/31/11	3/25/11
D18: Task 2 – Bell Creek Test Site PowerPoint Presentation (Update)	3/31/11	3/31/11
D26: Task 2 – Fort Nelson Test Site Poster	3/31/11	3/31/11
D28: Task 3 – Environmental Questionnaire – Bell Creek Test Site	3/31/11	3/30/11
D85: Task 6 – Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities	3/31/11	3/31/11
M23: Task 14 – Monthly WWG Conference Call Held	3/31/11	3/22/11
Year 4 – Quarter 3 (April–June 2011)		
M30: Task 5 – Bell Creek Test Site Baseline MVA Initiated	4/01/11	3/24/11
M23: Task 14 – Monthly WWG Conference Call Held	4/30/11	4/21/11
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/11	4/29/11
D88: Task 13 – Programmatic Risk Management Plan	4/30/11	4/29/11
D17: Task 2 – General Phase III Information PowerPoint Presentation (Update)	5/31/11	5/31/11
D34: Task 4 – Bell Creek Test Site – Baseline Hydrogeological Final Report	5/31/11	5/31/11

Continued . . .

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 4 – Quarter 3 (April–June 2011) (continued)		
M23: Task 14 – Monthly WWG Conference Call Held	5/31/11	5/5/11
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (Update)	6/30/11	6/30/11
M23: Task 14 – Monthly WWG Conference Call Held	6/30/11	6/23/11
M24: Task 14 – WWG Annual Meeting Held	6/30/11	5/5/11
Year 4 – Quarter 4 (July–September 2011)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/11	7/28/11
M23: Task 14 – Monthly WWG Conference Call Held	7/31/11	7/26/11
D29: Task 3 – Permitting Action Plan	8/31/11	8/31/11
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/11	8/31/11
D67: Task 9 – Fort Nelson Test Site – Simulation Report	7/31/11	8/31/11
M23: Task 14 – Monthly WWG Conference Call Held	8/31/11	8/24/11
D1: Task 1 – Review of Source Attributes	9/30/11	9/21/11
D4: Task 1 – Permitting Review – Basic EPA Requirements	9/30/11	9/30/11
D9: Task 1 – Updated DSS	9/30/11	9/23/11
D25: Task 2 – Bell Creek Test Site Poster	9/30/11	9/30/11
D50: Task 9 – Bell Creek Test Site – Site Characterization, Modeling, and Monitoring Plan	9/30/11	9/30/11
M23: Task 14 – Monthly WWG Conference Call Held	9/30/11	Waived by DOE
M31: Task 9 – Bell Creek Test Site – Site Characterization, Modeling, and Monitoring Plan Completed	9/30/11	9/30/11
M33: Task 16 – Basal Cambrian Baseline Geological Characterization Completed	9/30/11	9/29/11
Year 5 – Quarter 1 (October–December 2011)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/11	10/31/11
M23: Task 14 – Monthly WWG Conference Call Held	10/31/11	10/26/11
M23: Task 14 – Monthly WWG Conference Call Held	11/30/11	11/30/11
D57: Task 12 – Project Assessment Annual Report	12/31/11	12/30/11
M23: Task 14 – Monthly WWG Conference Call Held	12/31/11	Waived by DOE
M34: Task 16 – Basal Cambrian Static Geological Model Completed	12/31/11	12/21/11

Continued …

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 5 – Quarter 2 (January–March 2012)		
M16: Task 4 – Bell Creek Test Site – Initiation of Production and Injection Simulation	1/13/12	12/29/11
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/12	1/31/12
D65: Task 4 – Fort Nelson Test Site – Site Characterization Report	1/31/12	1/31/12
D81: Task 1 – Regional Carbon Sequestration Atlas (Update)	1/31/12	1/31/12
M23: Task 14 – Monthly WWG Conference Call Held	1/31/12	1/19/12
M29: Task 4 – Fort Nelson Site Characterization Report Completed	1/31/12	1/31/12
D91: Task 16 – Report – Geological Characterization of the Basal Cambrian System in the Williston Basin	2/29/12	2/29/12
M23: Task 14 – Monthly WWG Conference Call Held	2/29/12	2/28/12
D5: Task 1 – Second Target Area Completed	3/31/12	3/30/12
D18: Task 2 – Bell Creek Test Site PowerPoint Presentation (Update)	3/31/12	3/30/12
M10: Task 4 – Bell Creek Test Site Wellbore Leakage Data Collection Completed	3/31/12	3/12/12
M36: Task 13 – Annual Advisory Board Scheduled	3/31/12	3/28/12
M23: Task 14 – Monthly WWG Conference Call Held	3/31/12	3/27/12
Year 5 – Quarter 3 (April–June 2012)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/12	4/30/12
M23: Task 14 – Monthly WWG Conference Call Held	4/30/12	Waived by DOE
D17: Task 2 – General Phase III Information PowerPoint Presentation (Update)	5/31/12	5/31/12
M23: Task 14 – Monthly WWG Conference Call Held	5/31/12	5/31/12
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (Update)	6/30/12	6/29/12
D41: Task 4 – Fort Nelson Test Site – Geochemical Report	6/30/12	6/29/12
D84: Task 6 – Report – A Phased Approach to Building Pipeline Network for CO_2 Transportation During CCS	6/30/12	6/29/12
M23: Task 14 – Monthly WWG Conference Call Held	6/30/12	6/28/12
M24: Task 14 – WWG Annual Meeting Held	6/30/12	5/3/12
M32: Task 4 – Fort Nelson Geochemical Report Completed	6/30/12	6/29/12

Continued …

Table 7. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2011) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 5 – Quarter 4 (July–September 2012)		
D13: Task 2 – Public Site Updates	7/31/12	7/31/12
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/12	7/31/12
D67: Task 9 – Fort Nelson Test Site – Simulation Report	7/31/12	7/31/12
M23: Task 14 – Monthly WWG Conference Call Held	7/31/12	7/24/12
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/12	8/31/12
M23: Task 14 – Monthly WWG Conference Call Held	8/31/12	8/30/12
D1: Task 1 – Review of Source Attributes	9/30/12	9/28/12
D10: Task 1 – DPRS Update	9/30/12	9/28/12
M23: Task 14 – Monthly WWG Conference Call Held	9/30/12	9/27/12

Table 8. PCOR Partnership Phase III, BP4, PY3, and PY4 Gantt Chart

Continued…

Table 8. PCOR Partnership Phase III, BP4, PY3, and PY4 Gantt Chart (continued)

Continued…

Table 8. PCOR Partnership Phase III, BP4, PY3, and PY4 Gantt Chart (continued)

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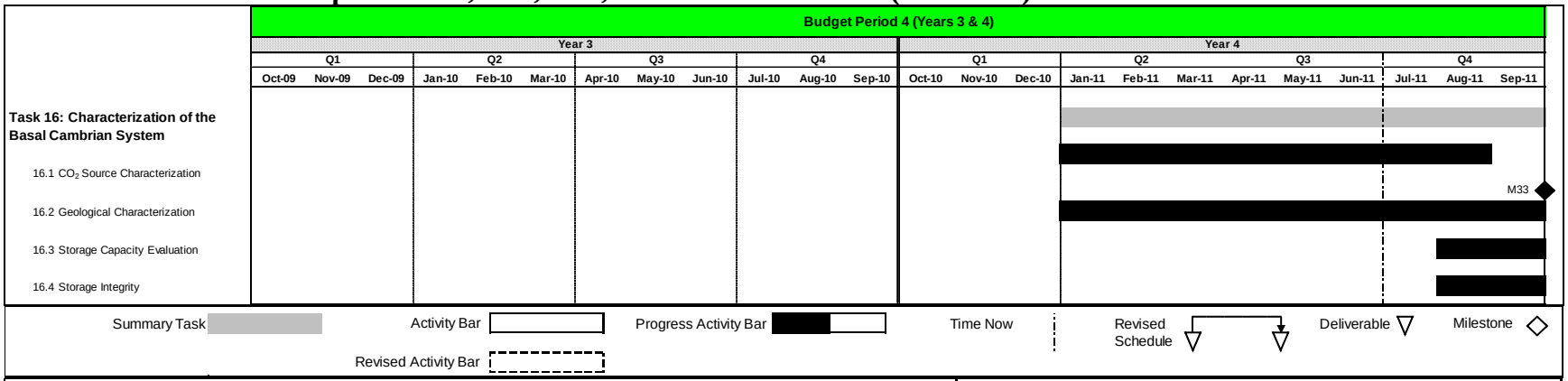
Table 8. PCOR Partnership Phase III, BP4, PY3, and PY4 Gantt Chart (continued)



Key for Deliverables (D) ▼			
D1	Review of Source Attributes	D29	Permitting Action Plan
D4	Permitting Review – Basic EPA Requirements	D31	BC Test Site – Geological Characterization Experimental Design Package
D9	Updated DSS	D34	BC Test Site – Baseline Hydrogeological Experimental Design Package
D10	DPRS Update	D50	BC Test Site – Site Characterization, Modeling, and Monitoring Plan
D11	Outreach Plan	D52	FN Test Site – Site Characterization, Modeling, and Monitoring Plan
D13	Public Site Updates	D57	Project Assessment Annual Report
D15	Bell Creek (BC) Test Site Fact Sheet	D58	Quarterly Progress Report
D16	Fort Nelson (FN) Test Site Fact Sheet	D59	Milestone Quarterly Report
D17	General Phase III Information PowerPoint Presentation	D66	BC Test Site – Simulation Report
D18	BC Test Site PowerPoint Presentation	D67	FN Test Site – Simulation Report
D19	FN Test Site PowerPoint Presentation	D78	White Paper – Nexus of CCS and Water
D20	Video Support to PowerPoint and Web Site	D81	Regional Carbon Sequestration Atlas (update)
D24	PCOR Partnership Region CO_2 Storage General Poster	D85	Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities
D25	BC Test Site Poster		
D26	FN Test Site Poster	D87	BC Test Site – Geomechanical Experimental Design Package
D28	BC Test Site – Environmental Questionnaire	D88	Programmatic Risk Management Plan

Key for Milestones (M) ◆	
M8	BC Test Site – Wellbore Leakage Data Collection Initiated
M9	BC Test Site – Geological Model Development Initiated
M23	Monthly WWG Conference Call Held
M24	WWG Annual Meeting Held
M28	BC Test Site – Geological Characterization Experimental Design Package Completed
M30	BC Test Site – Baseline MVA Activities Initiated
M31	BC Test Site – Site Characterization, Modeling, and Monitoring Plan Completed
M33	Basal Cambrian Baseline Geological Characterization Completed

Table 9. PCOR Partnership Phase III, BP4, PY5, and PY6 Gantt Chart

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Table 9. PCOR Partnership Phase III, BP4, PY5, and PY6 Gantt Chart (continued)

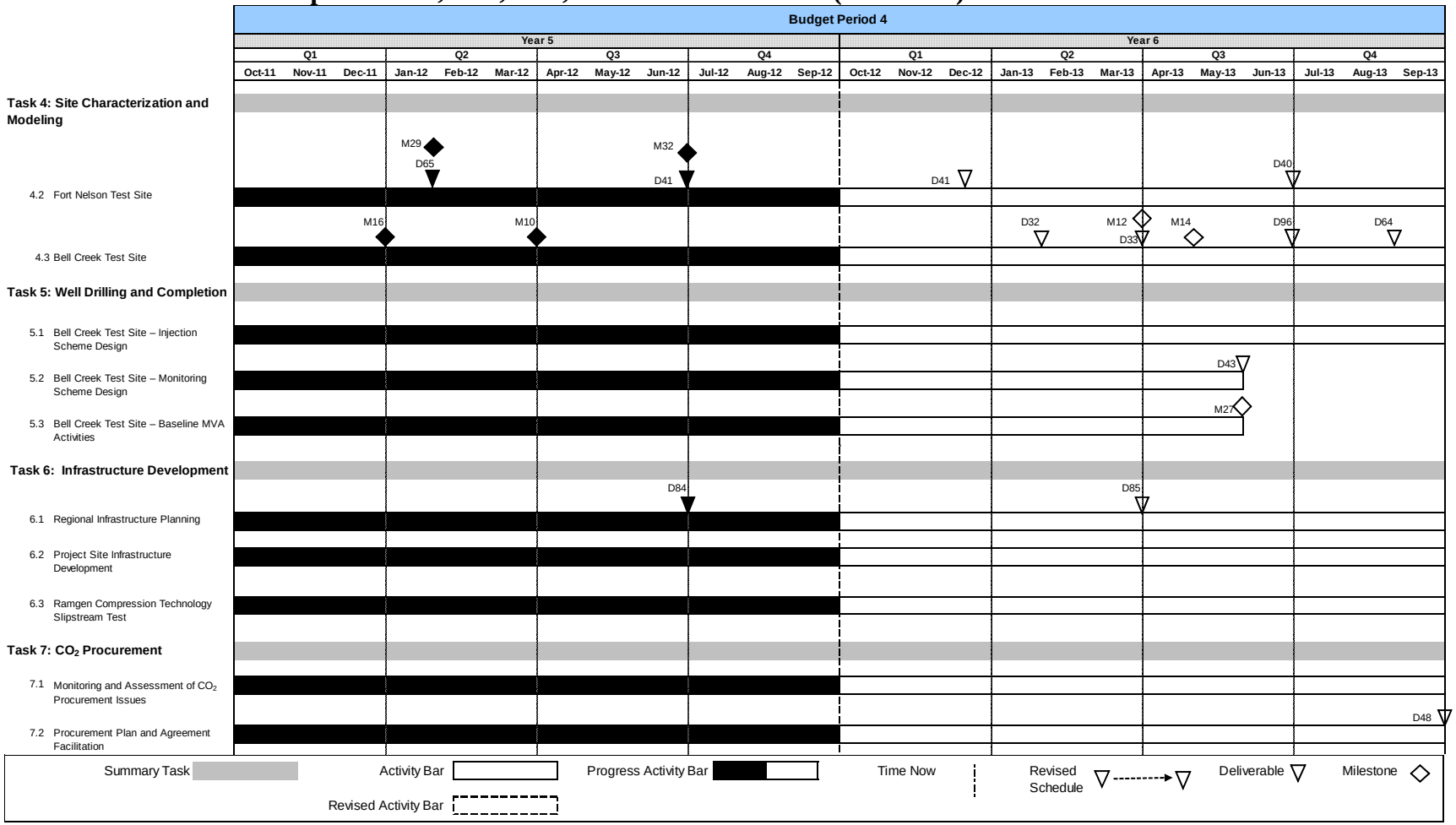

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Table 9. PCOR Partnership Phase III, BP4, PY5, and PY6 Gantt Chart (continued)

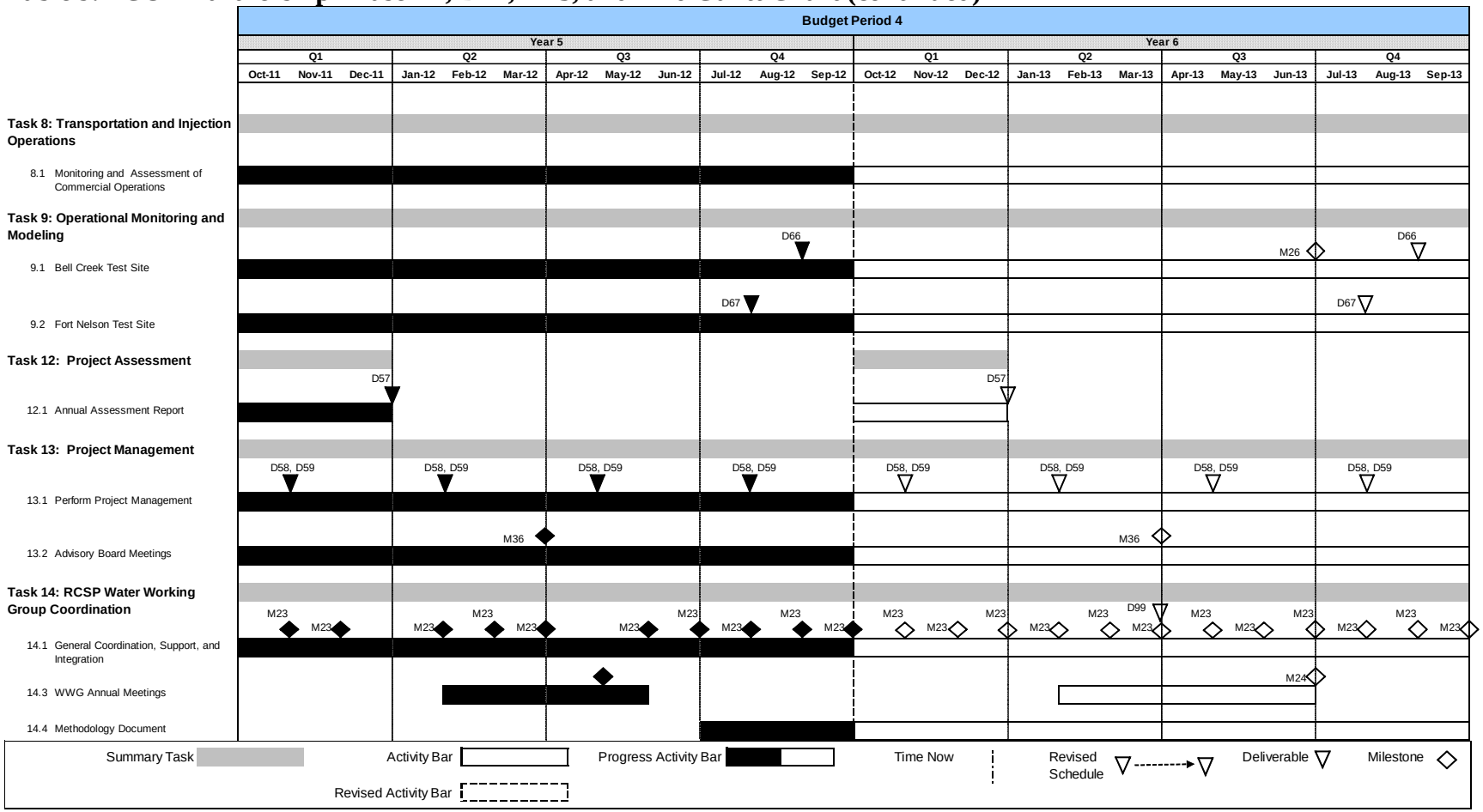

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Table 9. PCOR Partnership Phase III, BP4, PY5, and PY6 Gantt Chart (continued)

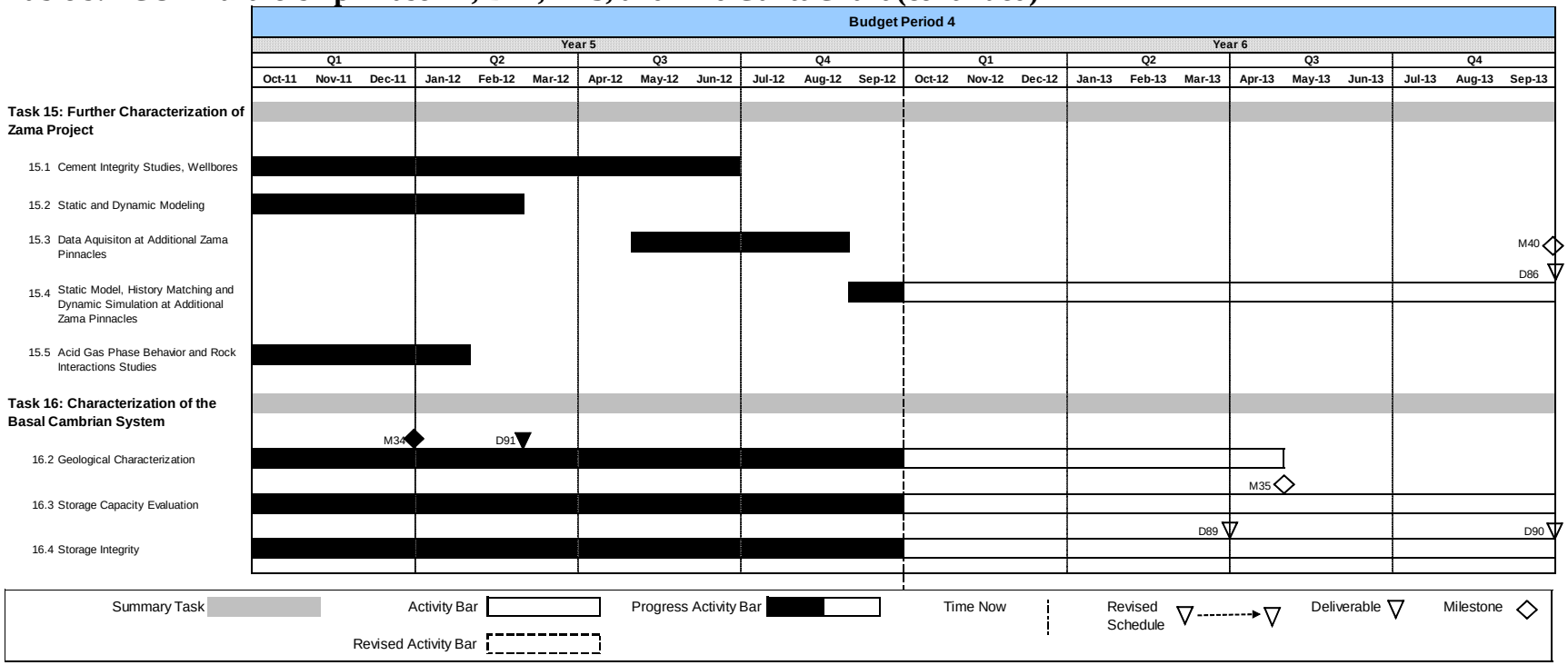

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Table 9. PCOR Partnership Phase III, BP4, PY5, and PY6 Gantt Chart (continued)

Key for Deliverables (D) ▼				Key for Milestones (M) ◆	
D1	Review of Source Attributes	D66	BC Test Site – Simulation Report	M10	BC Test Site – Wellbore Leakage Data Collection Completed
D5	Second Target Area Completed	D67	FN Test Site – Simulation Report	M12	BC Test Site – Preinjection Geochemical Work Completed
D6	Permitting Review – Update	D81	Regional Carbon Sequestration Atlas	M14	BC Test Site – Geological Characterization Data Collection Completed
D10	DPRS Update	D84	Report – A Phased Approach to Building Pipeline Network for CO_2 Transportation During CCS	M16	BC Test Site – Initiation of Production and Injection Simulations
D13	Public Site Updates			M23	Monthly WWG Conference Call Held
D14	General Phase III Fact Sheet	D85	Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities	M24	WWG Annual Meeting Held
D15	BC Test Site Fact Sheet			M26	BC Test Site – CO_2 Injection Initiated
D16	Fort Nelson Test Site Fact Sheet	D86	Updated Regional Technology Implementation Plan for Zama	M27	BC Test Site – MVA Equipment Installation and Baseline MVA Activities Completed
D17	General Phase III Information PowerPoint Presentation	D89	Report – Geochemical Evaluation of the Basal Cambrian System	M29	FN Test Site – Site Characterization Report Completed
D18	BC Test Site PowerPoint Presentation	D90	Report – Wellbore Evaluation of the Basal Cambrian System	M32	FN Test Site – Geochemical Report Completed
D19	FN Test Site PowerPoint Presentation	D91	Report – Geological Characterization of the Basal Cambrian System in the Williston Basin	M34	Basal Cambrian Static Geological Model Completed
D32	BC Test Site – Geomechanical Final Report			M35	Basal Cambrian Dynamic Capacity Estimation Completed
D33	BC Test Site – Preinjection Geochemical Report	D93	Geological Modeling and Simulation Report for the Aquistore Project	M36	Annual Advisory Board Meeting Scheduled
D40	FN Test Site – Geomechanical Report	D94	Aquistore Project Fact Sheet	M37	Subgroup Meetings Held
D41	FN Test Site – Geochemical Report	D95	Aquistore Project Poster	M38	Task Force Wrap-Up Meeting Held
D43	BC Test Site – Monitoring Experimental Design Package	D96	BC Test Site – 3-D Seismic Acquisition and Characterization Report	M39	Editing Subgroup Meeting Held
D48	BC Test Site – Procurement Plan and Agreement Report	D97	Report – Findings and Recommendations – GCS Task Force's Operational and Postoperational Liability Subgroups	M40	Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project Completed
D57	Project Assessment Annual Report				
D58	Quarterly Progress Report	D98	Report – Findings, Recommendations and Guidance of the GCS Task Force on Operational and Postoperational Liability		
D59	Milestone Quarterly Report				
D64	BC Test Site – Site Characterization Report	D99	Water/CCS Nexus Related Fact Sheet		
D65	FN Test Site – Site Characterization Report				

PLANNED ACTIVITIES

Task 1 – Regional Characterization

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Review and update attribute data for existing sources. Add additional attributes as necessary for characterization. Incorporate new sources as they come online (D1).

- Continue to work with the geological surveys/oil and gas divisions of the states and provinces to develop greater detail of the field and reservoir data.

- Complete the update of the regional carbon sequestration atlas (D81).

- Continue to update the DSS and DPRS, and report changes in the quarterly progress reports.

- Continue the detailed characterization of relevant oil fields located in the Cedar Creek Anticline.

- Prepare a report detailing geologic modeling and simulation activities for the Aquistore project (D93).

Task 2 – Public Outreach and Education

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Continue to review and improve the public PCOR Partnership Web site.

- Update the PowerPoint presentation for Phase III general activities (D17). Other PowerPoint presentations may be developed as needed.

- Continue to develop video products to meet the needs of general and site-level outreach.

- Continue to collaborate with PTRC on outreach activities related to the Aquistore project. These activities may include assisting in assembling material for public presentations, assisting in collection of information about public perception, participating in meetings with PTRC about public outreach activities, and potentially collecting video of the activities at the project site. A fact sheet and a poster will also be developed in collaboration with PTRC on the Aquistore project (D94 and D95).

- Update the demonstration project fact sheets (D15 and D16) and develop other fact sheets as needed.

- Identify and act on opportunities to provide outreach both at the regional level and in the vicinity of the demonstrations, and address needs with respect to general information on CO_2 storage as well as information on the specific demonstration projects. Activities may include public presentations; assembly of materials for the press and for specific audiences, including middle and high school students; conducting focus groups and undertaking other means of gaining audience feedback to gauge the knowledge of target audiences as well as the effectiveness of outreach materials; and working with outreach and education professionals in an effort to improve the effectiveness of outreach and education activities.

- Continue participation in the RCSP OWG, the Weyburn–Midale Outreach Advisory Panel, and the Aquistore Project Communications Advisory Group.

Task 3 – Permitting and NEPA Compliance

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Continue to gather information on current and planned CO_2 storage-related regulations at the state, province, and federal levels.

- Continue to facilitate the Regulatory Roundup meeting with regulators in the PCOR Partnership region.

- Interface with relevant regulatory agencies within the PCOR Partnership region as well as with federal regulatory agencies (United States and Canada) to understand the regulatory framework for project implementation.

- Continue participation in IOGCC activities as well as in the North Dakota CO_2 Storage Workgroup.

- Continue to address issues relating to liability (operational and postoperational) that remain as barriers to the establishment of state and federal legal and regulatory frameworks for CCUS.

Task 4 – Site Characterization and Modeling

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Fort Nelson test site

  – Prepare an update report detailing the geochemical evaluations and modeling by December 15, 2012.

  – Prepare a geomechanical report by June 30, 2013.

- Bell Creek Test Site

  – Prepare a geomechanical report by January 31, 2013.

  – Complete the preinjection geochemical work and prepare an associated report by March 31, 2013.

  – Complete the collection of geological characterization data by April 30, 2013.

  – Prepare a report detailing the 3-D seismic acquisition and characterization activities by June 30, 2013.

  – Prepare a site characterization report by August 31, 2013.

Task 5 – Well Drilling and Completion

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Develop an injection scheme that meets the technical and economic needs for the Bell Creek test project.

- Complete the installation of MVA equipment and complete the baseline MVA activities by May 31, 2013.

- Finalize the monitoring experimental design package including material needs and costs by May 31, 2013.

Task 6 – Infrastructure Development

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Prepare an update to the 2011 report detailing the opportunities and challenges associated with CO_2 compression and transportation during CCUS activities by March 31, 2013.

- Complete the interactive capture technologies table on the DSS.

- Complete an interactive table of compression technologies for the DSS.

- Continue to investigate regional infrastructure needs. Information will be made available for possible inclusion in the DSS.

- Continue to assist commercial partners with the activities required to develop the infrastructure to deliver CO_2 to the EOR site for the Bell Creek demonstration.

- Further investigate the issues associated with integration of advanced compression technology into a CO_2 storage project, and lay the groundwork for potential incorporation of the Ramgen technology into the Bell Creek demonstration project.

- Continue to work with the EERC's Partnership for CO_2 Capture (PCO_2C) Program in order to share resources and maximize the use of DOE funding.

Task 7 – CO_2 Procurement

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Continue to interface with commercial partners with respect to CO_2 procurement for CCS and EOR activities in the region.

- Continue to keep abreast of the various commercial issues associated with CO_2 procurement, such as contractual pricing mechanisms for CO_2, other potential customers, etc.

- Prepare a report describing the Bell Creek CO_2 procurement plan and agreement by September 30, 2013.

Task 8 – Transportation and Injection Operations

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Monitor and assess the CO_2 transport and injection operations conducted by the site owner/operator of the Bell Creek test site.

Task 9 – Operational Monitoring and Modeling

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Initiate CO_2 injection by June 30, 2013, and provide a quarterly summary of injection operations in the quarterly technical progress reports.

- Update the injection zone simulation modeling for the Fort Nelson test site by July 31, 2013.

- Update the reservoir simulation modeling for the Bell Creek test site by August 30, 2013.

Task 10 – Site Closure

No activity is anticipated during the next program year.

Task 11 – Postinjection Monitoring and Modeling

No activity is anticipated during the next program year.

Task 12 – Project Assessment

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Prepare the Annual Project Assessment Report (D57).

Task 13 – Project Management

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Continue to ensure timely production of deliverables and overall project management.
- Continue to expand the PCOR Partnership's membership base.
- Continue to update the TAB, and plan at least one meeting prior to the next annual meeting.
- Plan the next annual meeting.
- Continue to participate in and support RCSP efforts.
- Revise the project management plan as necessary.

Task 14 – RCSP WWG Coordination

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Continue to conduct monthly WWG conference calls.
- Plan and conduct the fifth annual meeting of the WWG.
- Prepare a fact sheet on water resource protection issues by March 31, 2013.

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- The regional technology implementation plan document developed in Phase II for the Zama project will be updated (D86) to incorporate the results of the added-on Phase III work.

Task 16 – Basal Cambrian System Characterization

During the next program year (October 1, 2012 – September 30, 2013), the following activities will be undertaken:

- Prepare a report describing the geochemical evaluation of the system by March 31, 2013.
- Complete the dynamic capacity estimation by April 30, 2013.
- Prepare a report on wellbore evaluation of the system by September 30, 2013.

PLANNED SCHEDULE

Table 10 contains all of the Phase III deliverables, milestones, and submission dates for PY6 (October 1, 2012 – September 30, 2013).

Table 10. Phase III Milestones and Deliverables

Title/Description	Due Date	Actual Completion Date
Year 6 – Quarter 1 (October–December 2012)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/12	
M23: Task 14 – Monthly WWG Conference Call Held	10/31/12	
M23: Task 14 – Monthly WWG Conference Call Held	11/30/12	
D57: Task 12 – Project Assessment Annual Report	12/31/12	
M23: Task 14 – Monthly WWG Conference Call Held	12/31/12	
M37: Task 3 – IOGCC Task Force Subgroup Meeting 1 Held	12/31/12	
Year 6 – Quarter 2 (January–March 2013)		
D32: Task 4 – Bell Creek Test Site – Geomechanical Final Report	1/31/13	
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/13	
D94:Task 2 – Aquistore Project Fact Sheet	1/31/13	
M23: Task 14 – Monthly WWG Conference Call Held	1/31/13	
D14: Task 2 – General Phase III Fact Sheet (Update)	2/28/13	
M23: Task 14 – Monthly WWG Conference Call Held	2/28/13	
D33: Task 4 – Bell Creek Test Site – Geochemical Final Report	3/31/13	
D85: Task 6 – Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities	3/31/13	
D89: Task 16 – Report – Geochemical Evaluation of the Basal Cambrian System	3/31/13	
D99: Task 14 – Water/CCS Nexus-Related Fact Sheet	3/31/13	
M12: Task 4 – Bell Creek Test Site Geochemical Work Completed	3/31/13	
M23: Task 14 – Monthly WWG Conference Call Held	3/31/13	
M36: Annual Advisory Board Meeting Scheduled	3/31/13	

Continued . . .

Table 10. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 6 – Quarter 3 (April–June 2013)		
D15: Task 2 – Bell Creek Test Site Fact Sheet (Update)	4/15/13	
D16: Task 2 – Fort Nelson Test Site Fact Sheet (Update)	4/30/13	
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/13	
M14: Task 4 – Bell Creek Test Site Geological Characterization Data Collection Completed	4/30/13	
M23: Task 14 – Monthly WWG Conference Call Held	4/30/13	
M35: Task 16 – Basal Cambrian Dynamic Capacity Estimation Completed	4/30/13	
D17: Task 2 – General Phase III Information PowerPoint Presentation (Update)	5/31/13	
D43: Task 5 – Bell Creek Test Site – Monitoring Experimental Design Package	5/31/13	
M23: Task 14 – Monthly WWG Conference Call Held	5/31/13	
M27: Task 5 – Bell Creek Test Site – MVA Equipment Installation and Baseline MVA Activities Completed	5/31/13	
D40: Task 4 – Fort Nelson Test Site – Geomechanical Final Report	6/30/13	
D93: Task 1 – Geological Modeling and Simulation Report for the Aquistore Project	6/30/13	
D96: Task 4 – Bell Creek Test Site – 3-D Seismic and Characterization Report	6/30/13	
D97: Task 3 – Report – Findings and Recommendations of CGS Subgroups	6/30/13	
M23: Task 14 – Monthly WWG Conference Call Held	6/30/13	
M24: Task 14 – WWG Annual Meeting Held	6/30/13	
M26: Task 8 – Bell Creek Test Site – CO_2 Injection Initiated	6/30/13	
M37: Task 3 – IOGCC Task Force Subgroup Meeting 2 Held	6/30/13	
Year 6 – Quarter 4 (July–September 2013)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/13	
D67: Task 9 – Fort Nelson Test Site – Simulation Report	7/31/13	
M23: Task 14 – Monthly WWG Conference Call Held	7/31/13	
D64: Task 4 – Bell Creek Test Site – Site Characterization Report	8/31/13	
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/13	
D81: Task 1 – Regional Carbon Sequestration Atlas (Update)	8/31/13	
M23: Task 14 – Monthly WWG Conference Call Held	8/31/13	

PROJECT RECOGNITION/TRAVEL

Project Recognition

John Harju continued his appointment as the Chairman of the Energy Resources, Research, and Technology Committee of the IOGCC. His term ran through January 2012.

John Harju continued to serve on DOE's Unconventional Resources Technology Advisory Committee (URTAC), which provides advice to the U.S. Secretary of Energy on the development and implementation of activities related to unconventional natural gas and other petroleum resources.

On June 29, 2012, the President of AAPG announced that the poster presentation entitled "Using Multiple-Point Statistics for Conditioning a Zama Pinnacle Reef Facies Model to Production History" was judged a "Top 10" Poster Presentation during the 2012 AAPG Annual Convention in Long Beach, California (Figure 32). The authors were commended for their presentation of significant content, reflecting originality, with outstanding organization and appearance. The authors will be listed in the May 2013 issue of the *AAPG Bulletin* and will also be acknowledged in the Annual Report of December 2013 *AAPG Bulletin*.

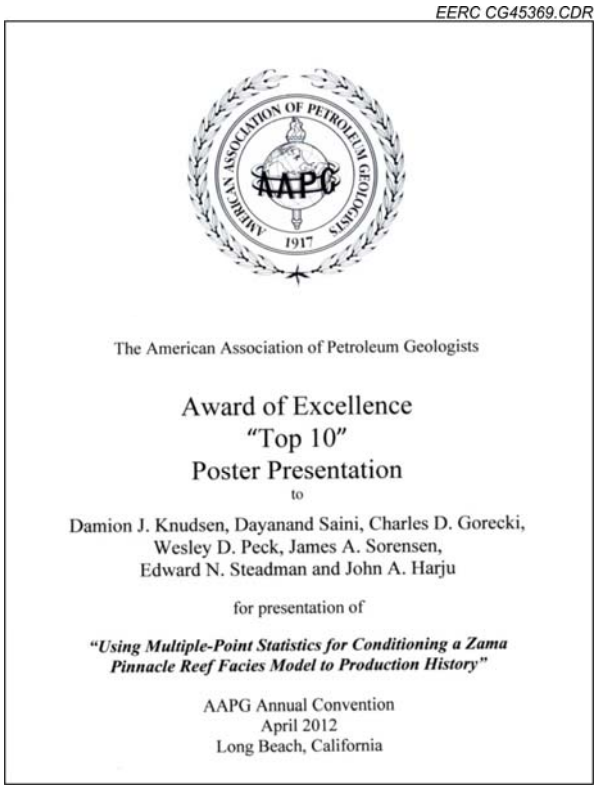

Figure 32. Certificate received for the AAPG Award of Excellence "Top 10" Poster Presentation at the 2012 AAPG Annual Convention in Long Beach, California.

Travel

Representatives from the PCOR Partnership attended and/or participated in the following 53 meetings/conferences, 14 training opportunities, and 30 project management site trips in this reporting period:

- October 2–7, 2011: Participated in a PetroSkills course entitled "CO_2 Surface Facilities" in Midland, Texas.
- October 5–13, 2011: Attended CMG training courses (2 days each) entitled "CMOST" and "CO_2 Sequestration with GEM" in Houston, Texas.
- October 7, 2011: Presented at the New Horizons Oil and Gas Conference at the South Dakota School of Mines in Rapid City, South Dakota.
- October 7–15, 2011: Presented at the SPE Forum "CO_2 Geological Storage: Will We Be Ready in Time?" held in The Algarve, Portugal.
- October 10, 2011: Participated in the PPB master teacher training group in Fargo, North Dakota.
- October 11–13, 2011: Attended the 2011 North Dakota GIS Users Conference in Grand Forks, North Dakota.
- October 15–18, 2011: Attended the IOGCC Annual Meeting and the PCOR Partnership Regulatory Group breakfast meeting in Buffalo, New York.
- October 16–19, 2011: Attended Schlumberger's training course entitled "Petrel Fracture Modeling" in Houston, Texas.
- October 18–20, 2011: Presented at the Storage in Saline Formations R&D Workshop in Pittsburgh, Pennsylvania.
- October 20 and 21, 2011: Attended the Education Minnesota Professional Conference in Minneapolis, Minnesota.
- October 22–27, 2011: Participated in Air Quality VIII: An International Conference on Carbon Management, Mercury, Trace Substances, SO_x, NO_x, and Particulate Matter, and the preconference Carbon Management Workshop in Arlington, Virginia.
- October 28 – November 13, 2011: Traveled for soil gas and groundwater sampling to the Bell Creek oil field in Montana.
- November 7–10, 2011: Attended the Midwest Geological Sequestration Consortium Science Conference in Champaign, Illinois.
- November 14, 2011: Traveled to the Lignite Field validation site near Kenmare, North Dakota.
- November 14–17, 2011: Attended CMG's "Unconventional Gas Modelling with IMEX and GEM" in Houston, Texas.
- November 14–17, 2011: Participated in the Carbon Storage Program Infrastructure Annual Review Meeting held in Pittsburgh, Pennsylvania.
- November 14–20, 2011: Visited the Montana Board of Oil & Gas Conservation to scan well logs in Billings, Montana.
- November 15–17, 2011: Presented at NPPD Power Summit in Lincoln, Nebraska.
- November 27 – December 3, 2011: Traveled to the Bell Creek test site area for continued baseline sampling.

- November 28 – December 1, 2011: Attended the National Ground Water Association Ground Water Expo in Las Vegas, Nevada.
- December 2–8, 2011: Attended a business dinner on December 4 and the 9th Annual Enhanced Oil Recovery Carbon Management Workshop on December 5–7, 2011, in Houston, Texas.
- December 4–6, 2011: Viewed the seismic check-shot survey at the Bell Creek oil field near Broadus, Montana.
- December 5, 2011 – January 4, 2012: Traveled to oversee drilling efforts at the Bell Creek oil field in southeastern Montana.
- December 6 and 7, 2011: Event staff conducted site visits for the upcoming annual meeting in Milwaukee, Wisconsin.
- December 7, 2011: Presented before an "Introduction to GIS" class at North Dakota State University in Fargo, North Dakota.
- December 12 and 13, 2011: Traveled to attend the drilling kickoff meeting at the Bell Creek oil field in Montana.
- December 13 and 14, 2011: Held the Fort Nelson quarterly meeting at Spectra's offices in Calgary, Alberta, Canada.
- December 21 and 22, 2011: EERC Director, UND President, and key program staff traveled to observe drilling efforts at the Bell Creek oil field in southeastern Montana.
- December 11, 2011 – January 10, 2012: Traveled to oversee drilling efforts at the Bell Creek oil field located in southeastern Montana.
- January 18–20, 2012: Attended meetings with Apache and Husky Energy in Calgary, Alberta, Canada.
- January 23–25, 2012: Participated in an abstract review meeting for the CCUS Conference in Arlington, Virginia.
- January 23–25, 2012: Attended the Groundwater Protection Council 2012 UIC Conference held in Houston, Texas.
- January 28 – February 4, 2012: Presented at EUEC in Phoenix, Arizona.
- January 30 – February 2, 2012: Participated in NACAP-6 meeting in Riviera Maya, Mexico.
- February 5–11, 2012: Viewed core samples at the Core Research Center and Core Labs in Denver, Colorado.
- February 6–12, 2012: Presented at Carbon Management Technology Conference in Orlando, Florida.
- February 14–17, 2012: Hosted the inaugural TAB meeting in San Diego, California.
- February 19–24, 2012: Attended a Schlumberger Information Solutions training course entitled "Techlog Formation Evaluation" in Houston, Texas.
- February 28 – March 5, 2012: Continued to view core samples at the Core Research Center and Core Labs in Denver, Colorado.
- February 27 – March 2, 2012: Visited Spectra's gas-processing plant and potential CO_2 injection site near Fort Nelson, British Columbia, Canada.
- March 13–15, 2012: Attended the North Dakota Petroleum Conference Spring Social in Denver, Colorado.
- March 19–20, 2012: Participated in a meeting with DOE and Spectra at NETL headquarters in Pittsburgh, Pennsylvania.

- March 21–23, 2012: Presented at the Workshop of CO_2 Geological Storage and EOR in Mexico City, Mexico (U.S. Energy Association paid for expenses).
- April 1–7, 2012: Participated in the Schlumberger Information Solutions Petrel 2011 Fundamentals and Petrel 2011 Geophysics training classes in Houston, Texas.
- April 15–18, 2012: Attended the 18th SPE Improved Oil Recovery Symposium in Tulsa, Oklahoma.
- April 17–19, 2012: Attended and presented at the U.S.–Canada project meeting in Regina, Saskatchewan, Canada.
- April 17–21, 2012: Visited the Bell Creek Field site near Miles City, Montana.
- April 17–22, 2012: Participated in FLAC 3-D Modeling Training in Minneapolis, Minnesota.
- April 21–26, 2012: Attended and presented at the AAPG Annual Convention and Exhibition in Long Beach, California.
- April 23–29, 2012: Traveled to the Bell Creek area for another round of baseline sampling (Event 2).
- April 27 – May 3, 2012: Attended and presented at the 11th Annual CCUS Conference in Pittsburgh, Pennsylvania.
- May 9–13, 2012: Attended meetings with Denbury management at its headquarters in Plano, Texas.
- May 14–18, 2012: Presented at the U.S.–Canada Clean Energy Dialogue 2 Bilateral Meeting on May 15 and at the MVA/MMV in Large-Scale CO_2 Injection Tests Workshop on May 16 and 17, both in Mobile, Alabama.
- May 17 and 18, 2012: Presented before the North Dakota Lignite Research Council on May 17 in Bismarck, North Dakota.
- May 16–18, 2012: Visited potential workshop locations for the Core Analysis Basics Workshop scheduled for September 11, 2012, in Milwaukee, Wisconsin.
- May 21–24, 2012: Attended and hosted an exhibit booth at the Williston Basin Petroleum Conference in Bismarck, North Dakota.
- May 22–26, 2012: Attended a Schlumberger training course entitled “Petrel 2011 Geology” in Bakersfield, California.
- May 29, 2012: Visited the Phase II Lignite Field validation test site to check on site closure and reclamation status near Kenmare, North Dakota.
- June 2–6, 2012: Participated in the IOGCC Mid-Year Meeting in Vancouver, British Columbia, Canada.
- June 3–5, 2012: Participated in the Teacher Training Institute entitled “The Changing Face of North Dakota” cosponsored by the North Dakota Geographic Alliance and PPB in Dickinson, North Dakota.
- June 4–7, 2012: Participated in CMG simulation training entitled “2-Day History-Matching & Optimization (CMOST)” in Houston, Texas.
- June 10–15, 2012: Participated in the CSLF Meetings of the Technical Group and Technical Workshop in Bergen, Norway.
- June 14 and 27, 2012: Visited the Phase II Lignite Field validation test site to check on site closure and reclamation status near Kenmare, North Dakota.
- June 15–26, 2012: Traveled to the Bell Creek Field to visit landowners and conduct Event 3 groundwater, soil gas, and surface water sampling in southeastern Montana.

- June 18–21, 2012: Presented at the CMG Technical Symposium in Calgary, Alberta, Canada.
- June 18–22, 2012: Participated in the IEAGHG 2nd Network Meeting in Santa Fe, New Mexico.
- June 22–28, 2012: Participated in the ISRM–ARMA Workshop on Petroleum Geomechanics Testing and the 46th ARMA Symposium in Chicago, Illinois.
- June 26–29, 2012: Presented at the CFE/APEC Workshop, Introducing CCS in Earth Sciences in Mexico City, Mexico.
- July 8–12, 2012: Attended the NETL 2012 CO_2 Capture Technology Meeting in Pittsburgh, Pennsylvania.
- July 10–13, 2012: Attended the EORI 6th Annual Wyoming CO_2 Conference in Casper, Wyoming.
- July 16–18, 2012: Participated in the Geologic CO_2 Sequestration: Reevaluating Storage Efficiency Estimates Workshop in Austin, Texas.
- July 16–19, 2012: Participated in the IEAGHG Environmental Impacts of CO_2 Storage Workshop in Bozeman, Montana.
- July 19, 2012: Traveled to the Phase II Lignite site near Kenmare, North Dakota.
- July 19–21, 2012: Presented at the Missouri Mineral Education Foundation Teacher Workshop in Park Hills, Missouri.
- July 22–27, 2012: Attended the Esri International User Conference in San Diego, California.
- July 26 – August 1, 2012: Attended Schlumberger OFM Fundamentals Training in Houston, Texas.
- July 29 – August 1, 2012: Hosted the 4th Annual Regulatory Roundup in Deadwood, South Dakota.
- August 1, 2012: Visited the (Phase II) Lignite site near Kenmare, North Dakota.
- August 1–3, 2012: Presented before the North Dakota Association of Rural Electric Cooperatives members services summer meeting in Hankinson, North Dakota.
- August 1–10, 2012: Presented at the 34th International Geological Congress in Brisbane, Australia.
- August 4–10, 2012: Traveled to the Bell Creek Field with PPB to film water and soil gas baseline sampling activities.
- August 6–17, 2012: Sampling team traveled to the Bell Creek Field for fourth-round baseline sampling.
- August 19–21, 2012: Participated in a log review meeting at Denbury's headquarters in Plano, Texas.
- August 19–24, 2012: Presented at the DOE Carbon Storage R&D Project Review meeting in Pittsburgh, Pennsylvania.
- August 21–25, 2012: Attended CMG simulation software training in Houston, Texas.
- August 22–25, 2012: Traveled to the Bell Creek Field to download temperature and pressure data at the monitoring well site near Broadus, Montana.
- August 27–31, 2012: Traveled to the Bell Creek Field to attend a seismic acquisition kickoff meeting that Denbury hosted near Broadus, Montana.
- September 4–6, 2012: Traveled to the Bell Creek oil field to film 3-D seismic acquisition activities with PPB in southeastern Montana.

- September 4–6, 2012: Presented at the 2012 CCS Binational Conference, Building a Business Case for CCS: Maintaining the Momentum for Large-Scale Demonstration Projects held September 5 in Regina, Saskatchewan, and participated in the field trip on September 6, to Estevan, Saskatchewan, to tour Aquistore and the Boundary Dam projects.
- September 7, 2012: Visited the (Phase II) Lignite site near Kenmare, North Dakota.
- September 9–13, 2012: Hosted the Core Analysis Basics Workshop and 2012 PCOR Partnership Annual Meeting at the InterContinental Hotel in Milwaukee, Wisconsin.
- September 11–15, 2012: Participated in TOUGH2 Training Course for Scientists and Engineers held at LBNL in Berkeley, California.
- September 11–22, 2012: Participated in the TOUGH 2012 Symposium and short courses held at LBNL in Berkeley, California.
- September 17–20, 2012: Traveled to the Bell Creek oil field with PPB to film pipeline construction activities.
- September 18–19, 2012: Traveled to the Bell Creek oil field for a site visit and to retrieve a vehicle previously damaged in a collision with a deer.
- September 20, 2012: Hosted an exhibit booth at the 2012 North Dakota Library Association Annual Conference in Fargo, North Dakota.
- September 27, 2012: Visited the (Phase II) Lignite site near Kenmare, North Dakota.

Materials presented at these meetings are available to partners on the PCOR Partnership DSS Web site (www2.undeerc.org/website/pcorp/ProductsDB/Default.aspx).

PHASE III PRODUCTS/PUBLICATIONS

During PY5, the PCOR Partnership submitted 34 abstracts, all but four of which were accepted; the author declined two and none are currently in review. The PCOR Partnership submitted three journal articles and gave 76 presentations (oral and poster combined). In addition, it completed 25 deliverable reports (17 of which were finalized), five milestone reports (five of which were finalized), and 17 progress reports (monthlies, quarterlies, and annual combined), and prepared several conference call and meeting minutes.

Abstracts

Submitted and Accepted for Presentation (28)

Braunberger, J.R., Peck, W.D., Bailey, T.P., Bremer, J.M., Huffman, B.W., and Gorecki, C.D., 2012, Subsurface core and analogous outcrop characterization of the Muddy/Newcastle Formation for the Bell Creek oil field, Powder River County, Montana [abs.]: Rocky Mountain Section – AAPG 2012, Grand Junction, Colorado, September 9–12, 2012.

Daly, D.J., Cumming, L., Garrett, G., Stone, M., Cather, M., Tollefson, L., and Wade, S., 2012, Visual message mapping for CCS outreach [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Daly, D.J., 2012, Regional Project-Based CCS Outreach – The PCOR Partnership Experience [abs.]: Developing the Technologies and Building the Infrastructure for CCUS Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 21–23, 2012.

Gorecki, C.D., Sorensen, J.A., Klapperich, R.J., Botnen, L.S., Steadman, E.N., and Harju, J.A., 2011, A risk-based monitoring plan for the Fort Nelson CCS project [abs.]: 2012 Carbon Management Technology Conference, Orlando, Florida, February 7–9, 2012.

Gorecki, C.D., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2011, Integrating CO_2 EOR and CO_2 storage in the Bell Creek oil field [abs.]: 2012 Carbon Management Technology Conference, Orlando, Florida, February 7–9, 2012.

Gorecki, C.D., Steadman, E.N., Harju, J.A., Sorensen, J.A., Hamling, J.A., Botnen, L.S., Peck, W.D., and Anagnost, K.K., 2012, The Plains CO_2 Reduction (PCOR) Partnership—CO_2 sequestration demonstration projects adding value to the oil and gas industry [abs.]: International Petroleum Technology Conference, Beijing, China, March 26–28, 2013.

Gorecki, C.D., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2012, Overview of the Bell Creek combined CO_2 storage and CO_2 EOR project [abs.]: 11th Annual Conference on Carbon Capture Utilization & Sequestration, Pittsburgh, Pennsylvania, April 30 – May 3, 2012.

Gorecki, C.D., Steadman, E.N., Harju, J.A., Sorensen, J.A., Hamling, J.A., Daly, D.J., Botnen, L.A., Jensen, M.D., Peck, W.D., and Anagnost, K.K., 2012, The Plains CO_2 Reduction (PCOR) Partnership — carbon capture, utilization, and storage demonstration activities [abs.]: 34th International Geological Congress, Brisbane, Australia, August 5–10, 2012.

Gorecki, C.D., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2012, Overview of the Bell Creek combined CO_2 storage and CO_2 EOR project [abs.]: 34th International Geological Congress, Brisbane, Australia, August 5–10, 2012.

Gorecki, C.D., Sorensen, J.A., Botnen, L.A., Steadman, E.N., Harju, J.A., Moffatt, D., Jenkins, M., and Laundry, A., 2012, Overview of the Fort Nelson CCS project [abs.]: 34th International Geological Congress, Brisbane, Australia, August 5–10, 2012.

Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2012, PCOR Partnership Phase III [abs.]: Developing the Technologies and Building the Infrastructure for CCUS Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 21–23, 2012.

Gorecki, C.D., Bailey, T.P., Liu, G., Sorensen, J.A., and Steadman, E.N., 2012, The role of static and dynamic modeling in the Fort Nelson CCS project [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Hamling, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2012, Overview of the Bell Creek combined CO_2 storage and CO_2 enhanced oil recovery project [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Jensen, M.D., Pei, P., Snyder, A.C., Heebink, L.V., and Cowan, R.M., 2012, A phased approach to developing a pipeline network for CO_2 transport during CCUS [abs.]: American Institute of Chemical Engineers 2012 Annual Meeting, Pittsburgh, Pennsylvania, October 28–November 2, 2012.

Jensen, M.D., Pei, P., Letvin, P.A., Snyder, A.C., Cowan, R.M., Gorecki, C.D., and Steadman, E.N., 2012, A phased approach to building a pipeline network for CO_2 transport during CCS [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Knudsen, D.J., Peck, W.D., and Bachu, S., 2011, CO_2 storage characterization of the basal aquifer system in the northern Great Plains prairie region of North America [abs.]: American Association of Petroleum Geologists (AAPG) 2012 Annual Convention & Exhibition, Long Beach, California, April 22–25, 2012.

Knudsen, D.J., Saini, D., Gorecki, C.D., Peck, W.D., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2011, Using multiple-point statistics for conditioning a Zama pinnacle reef facies model to production history [abs.]: American Association of Petroleum Geologists (AAPG) 2012 Annual Convention & Exhibition, Long Beach, California, April 22–25, 2012.

Liu, G., Gorecki, C.D., Bremer, J.M., Klapperich, R.J., Cowan, R.M., Holubnyak, Y.I., Knudsen, D.J., and Saini, D., 2012, Four-site case study of water extraction from CO_2 storage reservoirs [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Peck, W.D., Knudsen, D.J., Crotty, C.M., Sorensen, J.A., Gorecki, C.D., Bachu, S., Hauck, T., and Peterson, J., 2012, CO_2 storage resource potential of the Cambro-Ordovician saline system in the western interior of North America [abs.]: 11th Annual Conference on Carbon Capture Utilization & Sequestration, Pittsburgh, Pennsylvania, April 30 – May 3, 2012.

Peck, W.D., Knudsen, D.J., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., Bachu, S., and Peterson, J., 2012, CO_2 storage potential of the Cambro–Ordovician saline system in the western interior of North America [abs.]: Developing the Technologies and Building the Infrastructure for CCUS Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 21–23, 2012.

Peck, W.D., Bachu, S., Knudsen, D.J., Hauck, T., Crotty, C.M., Gorecki, C.D., Sorensen, J.A., Talman, S., Peterson, J., and Melnik, A., 2012, CO_2 storage resource potential of the Cambro–Ordovician saline system in the western interior of North America [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Saini, D., Gorecki, C.D., Hamling, J.A., Bailey, T.P., and Sorensen, J.A., 2012, Mechanism of subnormal pressure generation in the Bell Creek oil field and the implications to CO_2 storage [abs.]: International Petroleum Technology Conference, Beijing, China, March 26–28, 2013.

Saini, D., Gorecki, C.D., Knudsen, D.J., Sorensen, J.A., and Steadman, E.N., 2012, A simulation study of simultaneous acid gas EOR and CO_2 storage at Apache's Zama F Pool [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Sorensen, J.A., Gorecki, C.D., Botnen, L.A., Steadman, E.A., Harju, J.A., Moffatt, D., Jenkins, M., and Laundry, A., 2012, Overview, status, and future of the Fort Nelson CCS project [abs.]: 11th Annual Conference on Carbon Capture Utilization & Sequestration, Pittsburgh, Pennsylvania, April 30 – May 3, 2012.

Sorensen, J.A., Gorecki, C.D., Botnen, L.A., Steadman, E.N., and Harju, J.A., 2012, Overview, status, and future of the Fort Nelson CCS project [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Sorensen, J.A., Gorecki, C.D., Botnen, L.A., Steadman, E.N., and Harju, J.A., 2012, Overview, status, and future of the Fort Nelson CCS project [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Steadman, E.N., Harju, J.A., Gorecki, C.D., and Anagnost, K.K., 2011, The Plains CO_2 Reduction (PCOR) Partnership—progressing geologic storage through applied research [abs.]: 2012 Carbon Management Technology Conference, Orlando, Florida, February 7–9, 2012.

Steadman, E.N., Harju, J.A., Gorecki, C.D., Botnen, L.S., Daly, D.J., Jensen, M.D., Peck, W.D., Sorensen, J.A., Smith, S.A., Hamling, J.A., Klapperich, R.J., and Anagnost, K.K., 2012, The Plains CO_2 Reduction (PCOR) Partnership—a Regional Carbon Sequestration Partnership in the interior plains of North America [abs.]: EUEC 2013: Energy, Utility & Environment Conference, Phoenix, Arizona, January 28–30, 2013.

Submitted and Rejected for Presentation (4)

Daly, D.J., Crocker, C.R., Gorecki, C.D., and Steadman, E.N., 2012, Creating materials to convey the CCS message – PCOR Partnership experience [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Hamling, J.A., Gorecki, C.D., Braunberger, J.R., Botnen, B.W., Hu, H., Klapperich, R.J., Steadman, E.N., and Harju, J.A., 2012, Integrated monitoring program for a combined CO_2 enhanced oil recovery and CO_2 storage project in the Bell Creek oil field [abs.]: International Petroleum Technology Conference, Beijing, China, March 26–28, 2013.

Liu, G., Gorecki, C.D., Braunberger, J.R., Bailey, T.P., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2012, Method and case demonstration for integrated reservoir modeling and simulation optimization [abs.]: Society of Petroleum Engineers Reservoir Simulation Symposium, The Woodlands, Texas, February 18–20, 2013.

Liu, G., Gorecki, C.D., Braunberger, J.R., Bailey, T.P., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2012, An integrated optimization for reservoir modeling and simulation—method and case demonstration [abs.]: International Petroleum Technology Conference, Beijing, China, March 26–28, 2013.

Submitted and Withdrawn (2)

Bremer, J.M., Knudsen, D.J., Miller, D.J., Hawthorne, S.B., Gorecki, C.D., and Peck, W.D., 2012, Relative permeability of supercritical carbon dioxide to water for rocks of the Cambro-Ordovician saline system, North Dakota [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Smith, S.A., Holubnyak, Y.I., Hawthorne, S.B., Miller, D.J., Bremer, J.M., and Sorensen, J.A., 2012, Laboratory evaluation of wellbore casing steel and cements for the Zama acid gas EOR,

CO_2 storage, and monitoring project [abs.]: 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.

Presentations (64)

Botnen, L.S., 2012, PCOR Partnership overview and review of relevant federal activity: Presented at the Plains CO_2 Reduction (PCOR) Partnership Regulatory Roundup, Deadwood, South Dakota, July 31 – August 1, 2012.

Botnen, L.S., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2011, Plains CO_2 Reduction (PCOR) Partnership: Presented to the Public Lands Committee at the 2011 Interstate Oil and Gas Compact Commission Annual Meeting, Buffalo, New York, October 17–18, 2011.

Braunberger, J.R., 2012, Modeling and simulation update: Presented at the Bell Creek CCS Project quarterly meeting, Grand Forks, North Dakota, June 26, 2012.

Braunberger, J.R., 2012, Plains CO_2 Reduction Partnership's geological-based activities: Presented to the North Dakota State University Geology Club, Grand Forks, North Dakota, April 19, 2012.

Braunberger, J.R., 2011, Geographic information systems in the PCOR Partnership: Lecture presented at North Dakota State University, Fargo, North Dakota, December 7, 2011.

Braunberger, J.R., 2011, Overview of geologic CO_2 storage—focus on PCOR: Presented at the Nebraska Public Power District/Nebraska Department of Environmental Quality (NPPD/NDEQ) Power Summit, Lincoln, Nebraska, November 16, 2011.

Braunberger, J.R., 2011, Rival geologic model update: Presented to TAQA North Ltd. personnel, Grand Forks, North Dakota, October 21, 2011.

Braunberger, J.R., 2011, Rival modeling and simulation – proposed path forward: Presented to TAQA North Ltd. personnel, Grand Forks, North Dakota, October 21, 2011.

Bremer, J.M., 2011, Grenora Field geomechanics: Presented to TAQA North Ltd. personnel, Grand Forks, North Dakota, October 20, 2011.

Bremer, J.M., 2011, Rival Field laboratory analysis: Presented to TAQA North Ltd. personnel, Grand Forks, North Dakota, October 21, 2011.

Daly, D.J., 2012, Best practices in public outreach – what have we learned?: Presentation and panel discussion for the Outreach and Public Engagement Workshop at the 11th Annual Conference on Carbon Capture Utilization & Sequestration, Pittsburgh, Pennsylvania, April 30 – May 3, 2012.

Daly, D.J., 2012, Energy and carbon—the big picture (Foundations I): Presented at The Changing Face of North Dakota Teacher Training Institute, Dickinson, North Dakota, June 4–8, 2012.

Daly, D.J., 2012, Energy and CO_2 management—regional options (Foundations II): Presented at The Changing Face of North Dakota Teacher Training Institute, Dickinson, North Dakota, June 4–8, 2012.

Daly, D.J., 2012, Energy and CO_2 management—carbon capture and storage: Presented at the 2012 Lignite Education Seminar, Bismarck, North Dakota, June 19, 2012.

Daly, D.J., 2012, PCOR Partnership outreach update—Fort Nelson project: Presented at the Plains CO_2 Reduction (PCOR) Partnership Fort Nelson Technical and Quarterly Meeting, Grand Forks, North Dakota, June 6–7, 2012.

Daly, D.J., 2012, Plains CO_2 Reduction (PCOR) Partnership outreach update – Bell Creek Project: Presented at the Bell Creek CCS Project quarterly meeting, Grand Forks, North Dakota, June 26, 2012.

Ge, J., 2012, Geomechanical modeling for Fort Nelson CCS project: Presented at the Plains CO_2 Reduction (PCOR) Partnership Fort Nelson Technical and Quarterly Meeting, Grand Forks, North Dakota, June 6–7, 2012.

Gorecki, C.D., 2012, The Plains CO_2 Reduction (PCOR) Partnership—carbon capture, utilization, and storage demonstration activities: Presented at the 34th International Geological Congress, Brisbane, Australia, August 5–10, 2012.

Gorecki, C.D., 2012, The Plains CO_2 Reduction (PCOR) Partnership carbon capture, utilization, and storage demonstration activities: Presented at the Plains CO_2 Reduction (PCOR) Partnership Annual Meeting, Milwaukee, Wisconsin, September 11–13, 2012.

Gorecki, C.D., 2012, Plains CO_2 Reduction (PCOR) Partnership Phase III: Presented at the U.S. Department of Energy National Energy Technology Laboratory Research & Development Project Review Meeting, Pittsburgh, Pennsylvania, August 21–23, 2012.

Gorecki, C.D., 2012, Bell Creek CO_2 EOR and CO_2 storage demonstration project, Montana: Presented at the International Workshop on Knowledge Sharing in MVA/MMV in CCS Demonstration Projects and Large-Scale CO_2 Injection Tests, Mobile, Alabama, May 16–17, 2012.

Gorecki, C.D., 2012, Overview of the Bell Creek integrated CO_2 EOR and CO_2 storage project in Montana and Basal Cambrian characterization activities: Presented at the U.S.–Canada Bilateral Meeting, Mobile, Alabama, May 15, 2012.

Gorecki, C.D., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2012, Overview of the Bell Creek integrated CO_2 EOR and CO_2 storage project in Montana: Presented to Schlumberger Carbon Services personnel, Grand Forks, North Dakota, May 9, 2012.

Gorecki, C.D., Liu, G., Pu, H., Braunberger, J.R., Hamling, J.A., Saini, D., and Sorensen, J.A., 2012, Use of CMG's GEM and CMOST for modeling CO_2 storage and CO_2 EOR for the PCOR Partnership Program: Presented at CMG's 2012 Technical Symposium on Reservoir Simulation Technology, Calgary, Alberta, June 19–21, 2012.

Gorecki, C.D., 2012, A risk-based monitoring plan for the Fort Nelson feasibility project: Presented at the 2012 Carbon Management Technology Conference, Orlando, Florida, February 7–9, 2012.

Gorecki, C.D., 2012, Integrating CO_2 EOR and CO_2 storage in the Bell Creek oil field: Presented at the 2012 Carbon Management Technology Conference, Orlando, Florida, February 7–9, 2012.

Gorecki, C.D., 2012, Plains CO_2 Reduction (PCOR) Partnership update: Presented to Battelle Energy Systems and Carbon Management Group personnel and Core Energy, LLC, personnel, Grand Forks, North Dakota, January 25, 2012.

Gorecki, C.D., 2011, An overview of CO_2 storage capacity estimation, *in* Proceedings of Air Quality VIII: An International Conference on Carbon Management, Mercury, Trace Substances, SO_x, NO_x, and Particulate Matter: Arlington, Virginia, October 24–27, 2011.

Gorecki, C.D., 2011, Plains CO_2 Reduction (PCOR) Partnership update: Presented at the 2011 Carbon Storage Program Infrastructure Annual Review Meeting, Pittsburgh, Pennsylvania, November 15–17, 2011.

Gorecki, C.D., 2011, Plains CO_2 Reduction (PCOR) Partnership—large-scale demonstration projects in the central interior of North America, *in* Proceedings of Air Quality VIII: An International Conference on Carbon Management, Mercury, Trace Substances, SO_x, NO_x, and Particulate Matter: Arlington, Virginia, October 24–27, 2011.

Gorecki, C.D., 2011, Quantifying and enhancing CO_2 storage capacity: Presented at the Storage in Saline Formations R&D Workshop, Pittsburgh, Pennsylvania, October 19–20, 2011.

Hamling, J.A., 2012, Overview of the Bell Creek combined CO_2 storage and CO_2 EOR project: Presented at the 34th International Geological Congress, Brisbane, Australia, August 5–10, 2012.

Jensen, M.D., 2011, Overview of CO_2 capture research by the Plains CO_2 Reduction Partnership and the Partnership for CO_2 Capture: Presented at the Nebraska Public Power District/Nebraska Department of Environmental Quality (NPPD/NDEQ) Power Summit, Lincoln, Nebraska, November 16, 2011.

Knudsen, D.J., and Saini, D., 2012, Zama F Pool acid gas EOR and CO_2 Storage—modeling and simulation: Presented to Battelle Energy Systems and Carbon Management Group personnel and Core Energy, LLC, personnel, Grand Forks, North Dakota, January 25, 2012.

Knudsen, D.J., and Saini, D., 2012, Zama F Pool acid gas EOR and CO_2 storage—modeling and simulation: Presented to Computer Modelling Group Ltd. personnel, Grand Forks, North Dakota, March 29, 2012.

Liu, G., 2012, Fort Nelson CCS project—simulation summary: Presented at the Plains CO_2 Reduction (PCOR) Partnership Fort Nelson Technical and Quarterly Meeting, Grand Forks, North Dakota, June 6–7, 2012.

Melzer, S., 2011, CO_2 enhanced oil recovery, *in* Proceedings of Air Quality VIII: An International Conference on Carbon Management, Mercury, Trace Substances, SO_x, NO_x, and Particulate Matter Preconference Workshops: Arlington, Virginia, October 23, 2011.

Melzer, S., Harju, J.A., Steadman, E.N., and Pavlish, B.M., 2011, CO_2 separation and capture—status, challenges, and opportunities, *in* Proceedings of Air Quality VIII: An International Conference on Carbon Management, Mercury, Trace Substances, SO_x, NO_x, and Particulate Matter Preconference Workshops: Arlington, Virginia, October 23, 2011.

Peck, W.D., 2012, Geologic concepts and CCS: Presented at the Plains CO_2 Reduction (PCOR) Partnership Annual Meeting Core Analysis Basics Workshop, Milwaukee, Wisconsin, September 11, 2012.

Peck, W.D., 2012, Plains CO_2 Reduction (PCOR) Partnership update on the Basal Cambrian Saline System Project: Presented at the Technical Committee Meeting for the Basal Aquifer

Project, Plains CO_2 Reduction (PCOR) Partnership Annual Meeting, Milwaukee, Wisconsin, September 11–13, 2012.

Peck, W.D., 2012, CO_2-based enhanced oil recovery: Presented at the CFE/APEC Workshop for Introducing Carbon Capture and Storage in Earth Sciences Undergraduate Programs, Mexico City, Mexico, June 27–28, 2012.

Peck, W.D., 2012, CO_2 storage resource potential of the Cambro-Ordovician saline system in the western interior of North America: Presented at the Basal Aquifer Project Meeting, Regina, Saskatchewan, April 18, 2012.

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Progress Reports

Monthlies (12)

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Gorecki, C.D., Steadman, E.N., Peck, W.D., Daly, D.J., Botnen, L.S., Sorensen, J.A., Hamling, J.A., Jensen, M.D., Harju, J.A., Anagnost, K.K., and Klapperich, R.J., 2012, Plains CO_2 Reduction (PCOR) Partnership: Phase III monthly report (July 1–31, 2012) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, August.

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