Award Number: DE-FE0029474

Integrated CCS for Kansas (ICKan)

DUNS NUMBER**:** 076248616

Research Performance Progress Report (Quarterly)

Submitted to:
The Department of Energy
National Energy Technology Laboratory

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Date of Report: 07/17/18

Project Period: March 15, 2017 to September 15, 2018

Period Covered by the Report: March 1, 2018 to May 31, 2018

Signature of submitting official:

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INTRODUCTION

A. OBJECTIVES

This *Phase I- Integrated CCS Pre-Feasibility Study* activity under CarbonSAFE will evaluate and develop a plan and strategy to address the challenges and opportunities for commercial-scale Carbon Capture and Storage (CCS) in Kansas, *ICKan (Integrated CCS for Kansas)*. The objectives of *ICKan* include identifying and addressing the major technical and nontechnical challenges of implementing CO_2 capture and transport and establishing secure geologic storage for CO_2 in Kansas. The study will examine three of Kansas' largest CO_2 point sources and corresponding storage sites, each with an estimated 50+ million tons capacity (of saline aquifer storage), and a local transportation network to connect with nearby geologic storage. The project will also provide high level technical sub-basinal evaluation, building on previous characterization of the regional stacked storage complex.

B. SCOPE OF WORK

ACCS Coordination Team will examine three of Kansas' largest CO_2 point sources and corresponding storage sites, each with an estimated 50+ million tons capacity, and a local transportation network to connect with nearby geologic storage. ICKan will evaluate and develop a plan and strategy to address the challenges and opportunities for commercial-scale CCS in Kansas. The *Team* will identify and address the major technical and nontechnical challenges of implementing capture, transportation, and secure geologic storage of CO_2 in Kansas.

The ICKan and CCS Coordination Team will generate information that will allow DOE to make a determination of the proposed storage complex's level of readiness for additional development under Phase II, by establishing and addressing the key challenges in commercial scale capture, transportation, and storage in this investigation.

C. TASKS TO BE PERFORMED

Task 1.0 – Project Management and Planning Integrated CCS for Kansas (ICKan)
This Task includes the necessary activities to ensure coordination and planning of the project with DOE/NETL and other project participants. These activities include, but are not limited to, the monitoring and controlling of project scope, cost, schedule, and risk, and the submission and approval of required National Environmental Policy Act (NEPA) documentation

This Task includes all work elements required to maintain and revise the Project Management Plan, and to manage and report on activities in accordance with the plan.

Subtask 1.1 - Fulfill requirements for National Environmental Policy Act (NEPA) documentation
Phase I shall not involve work in the field, thus the activities shall have no adverse impact on the environment. Potential future activities that could have negative environmental impact in subsequent project phases will be documented in the Phase I reports.

Subtask 1.2 - Conduct a kick-off meeting to set expectations
The PIs shall layout expectations for adherence to scope, schedule, budget, risk management, and overall project plan in an "all-hands" meeting within the first four weeks of project initiation. The PIs shall provide protocols and reporting mechanisms for notice of modifications.

Subtask 1.3 - Conduct regularly scheduled meetings and update tracking

The team shall hold regularly scheduled monthly meetings including all personnel and subcontractors via conference calls or online videoconferences. The PIs shall update scope, tasks, schedule, costs, risks, and distribute to the DOE and the project team. Accountability shall be encouraged by the monthly review sessions. The PIs shall hold full CCS team meetings (including CO_2sources and field operators) quarterly.

Subtask 1.4 - Monitor and control project scope
PIs shall evaluate and analyze monthly reports from all team section leads ensuring compliance with the requirements of DOE.

Subtask 1.5- Monitor and control project schedule
PIs shall closely monitor adherence to the project schedule, facilitated by monthly project team meetings. Schedule tracking and modifications shall be provided to the team on a monthly basis. PI will monitor resources to ensure timely completion of tasks.

Subtask 1.6 - Monitor and control project risk
Project risks and mitigation protocol shall be discussed with the team at the beginning of the project to help limit risks being realized and help recognize patterns that could signal increased risk.

Subtask 1.7 - Finalize the DMP. The DMP and its components shall be finalized by the PI. Information acquired, during the project, will be shared via the NETL-EDX data portal including basic and derived information used to describe and interpret the data and supplementary information to a published document. Information will be protected in accordance with the usage agreements and licenses of those who contribute the data.

Subtask 1.8 - Revisions to the PMP after submission
The PMP shall be updated as needed, including:1) details from the negotiation process through consultation with the Federal Project Officer, 2) revisions in schedule, 3) modifications in the budget, 4) changes in scope and tasks, 5) additions or changes in personnel, and 5) other material changes in the project.

Subtask 1.9 - Develop an integrated strategy/business plan for commercial scale CCS
The PIs shall set goals and timelines in early meetings and the team shall develop and build on strategy that will be documented in a business plan.

Task 2.0 – Establish a Carbon Capture and Storage (CCS) Coordination Team
The PIs shall develop a multidisciplinary team capable of addressing technical and non-technical challenges specific to commercial-scale deployment of the CO_2storage project. The Phase I team will 1) determine if any additional expertise and manpower required for Phase II, 2) recommend individuals, groups or institutions to fill any additional needs that are identified, and 3) assist in the recruitment and gaining formal commitments by key individuals or institutions for Phase II.

Subtask 2.1 - Identify additional CCS team members
Identify additional team members required to evaluate; 1) geologic storage complex, 2) large-scale anthropogenic sources and approaches to capturing CO_2, 3) transportation/delivery systems from source to the geologic complexes and injection into the storage reservoir, 4)costs, economics and financial requirements, 5) legal and political challenges, and 6) public outreach for the Phase II effort. Future needs will also be evaluated and additional team members will be selected if there are additional gaps in technical or non-technical areas that would be advisable to fill.

Subtask 2.2 - Identify additional stakeholders that should be added to the CCS team
The team will identify possible additional stakeholders that could include environmental groups, business

groups, state legislators, state organizations (commerce), rate-payer organizations, land use and land owner groups.

Subtask 2.3 - Recruit and gain commitment of additional CCS team members identified
A comprehensive review of the gap analyses and develop recommendations of additional individuals, groups or institutions which should be filled before proceeding to Phase II. The CCS team shall identify primary and secondary choices, recruit, and gain commitments for possible participation in Phase II.

Subtask 2.4 - Conduct a formal meeting that includes the Phase I team and committed Phase II team members
A one-day working meeting will be conducted to1) review Phase I preliminary results, 2) present draft plans for Phase II, and3) gather input from recruited potential Phase II members. The meeting shall be held at the KGS or a mutually agreed upon alternate site with an option to participate by videoconferencing.

Task 3.0 – Develop a plan to address challenges of a commercial-scale CCS Project
This application presents three candidate sources and identifies three possible geologic complexes suitable for storage. Phase I work shall determine which are most feasible, and shall identify and develop a preliminary plan to address the unique challenges of each source/geologic complex that may be feasible for commercial-scale CCS (50+ million tonnes captured and stored in a saline aquifer). Reliable and tested approaches, such as Road mapping and related activities (Phaal, et al., 2004, Gonzales-Salavar, et al., 2016; IEA, 2013: DOE, 2003) shall be used to identify, select, and establish alternative technical and non-technical options based on sound, transparent analyses including monitoring for adjustment as the assessment matures.

Subtask 3.1 - Identify challenges and develop a plan to address challenges for CO_2 capture from anthropogenic sources
A plan will be developed that addresses CO_2 capture including use of plant configuration, current and anticipated operating conditions, product distribution (e.g. electrical power grid), and regulatory uncertainty.

Subtask 3.2 - Identify challenges and develop a plan to address challenges for CO_2 transportation and injection
A plan will be developed that describes challenges specific to Kansas to deliver $CO_2$to the injection well(s) including addressing regulations, right of way, pipeline configuration, maintenance, safety, and deliverability.

Subtask 3.3 - Identify challenges and develop a plan to address challenges for CO_2 storage in geologic complexes
The KGS shall evaluate candidate geological complexes for technical risks (capacity, seal, faults, seismicity, pressure, existing wellbores), economics (location/distance, injectivity, availability), and legal (pore space rights, liability) and document the results in a plan.

Task 4.0 – Perform a high level technical sub-basinal evaluation using NRAP and related DOE tools
Three candidate sources and two possible storage complexes were identified. Phase I work shall determine which are most feasible, and will identify and develop a plan to address the unique challenges of each storage complex that may be feasible for commercial-scale CCS (50+ Mt captured and stored in a saline aquifer).Each location will be evaluated using NRAP models and the results shall be submitted to DOE.

Subtask 4.1 - Review storage capacity of geologic complexes identified in this proposal and consider alternatives

Three possible sites in two complexes are in various stages of analysis and each appears to meet the50+Mt storage requirement. They shall be further evaluated and a survey of other potential geologic structures will undergo a rigorous site screening and selection process to determine suitability.

Subtask 4.2 - Conduct high-level technical analysis of suitable geologic complexes using NRAP- IAM-CS and other tools for integrated assessment
The KGS shall evaluate candidate storage complexes in terms of capacity, seal, faults, seismicity, pressure, existing wellbores, and injectivity.

Subtask 4.3 - Compare results using NRAP with methods used in prior DOE contracts including regional and sub-basin CO_2 storage
The CCS team shall use the results of the NRAP models obtained in this study with the regional simulation of CO_2 storage in southern Kansas to provide an assessment of risk to this greater area and compare with findings of project DE-FE0002056, including Pleasant Prairie Field and other potentially prospective storage sites (e.g., Eubank, Cutter, and Shuck fields).

Subtask 4.4 - Develop an implementation plan and strategy for commercial-scale, safe and effective CO_2 storage
A technology roadmap or similar methodology shall be used to convey a detailed realistic implementation plan and strategy that shall utilize the experience gained by the KGS in developing a US EPA Class VI permit. The result shall be based on a sound analysis that meets the goals of stakeholders, defines effective action, and is adaptable and open for review and updates as conditions change, e.g., new technology breakthroughs, incentivizing, and market conditions (McDowall, 2012).

Task 5.0 – Perform a high level technical CO_2 source assessment for capture
An assessment of the capture technologies best suited for efficiency, addressing the concerns of the electric utilities and their operating requirements and economic needs will be performed.

Subtask 5.1 - Review current technologies and CO_2 sources of team members and nearby sources using NATCARB, Global CO_2 Storage Portal, and KDM
The CCS team shall develop an organized electronic clearinghouse of vital information pertaining to the project, ranked by suitability, historical usage records, adaptability, scaling, and demonstration of success, and operations and maintenance requirements.

Subtask 5.2 - Determine novel technologies or approaches for CO_2 capture
CO_2 sources shall carefully be evaluated for suitability with new capture technologies. The evaluation will utilize private research including that sponsored by DOE and results of international efforts and projects such as DOE's Carbon Capture Simulation Initiative (CCSI) to determine the suitability and rational for making decisions to pursue or table the technology.

Subtask 5.3 - Develop an implementation plan and strategy for cost effective and reliable carbon capture
An optimal CCS plan and strategy that best represents the holistic operating environment and requirements of the CO_2 sources will be developed. The team shall develop a means to ensure a mechanism to update and adapt to new disruptive technologies and possibly accommodate them in the design document.

Task 6.0 – Perform a high level technical assessment for CO_2 transportation
The CCS team shall consider best practices in pipeline design to ensure safety, security, and compliance with regulations in force in Kansas and other states were the pipeline may extend.

Subtask 6.1 - Review current technologies for CO_2 transportation
The CCS team shall address the challenges in pipeline transportation and shall catalog and classify the

technologies best suited for use in Kansas.

Subtask 6.2 - Determine novel technologies or approaches for CO_2 transportation
The CCS team shall review the challenges and solutions conveyed by current research and development and using a SWOT analysis determine the suitability and rational for making a decision to pursue or table transportation technologies.

Subtask 6.3 - Develop a plan for cost-efficient and secure transportation infrastructure
The CCS team shall develop an optimal plan and strategy for aCO_2distribution system that aligns with the needs of the proposed CO_2 sources and the storage complex put forth by the team.

Task 7.0 – Technology Transfer

Subtask 7.1 - Maintain website on KGS server to facilitate effective and efficient interaction of the team
The KGS shall create and maintain a web site available to both the members of the CCS team and the public. A non-secured site portion of the site shall be dedicated to apprising the public on the status of the on-going project as well as publishing the acquired data. The format of the public site shall be directed toward both technical and non-technical audiences. The public site will contain all non- confidential reports, public presentations, and papers. All data developed by the project or interpretation of existing data, performed by the project, shall be uploaded to EDX (edx.netl.doe.gov).

Subtask 7.2 - Public presentations
Progress and information gained from the study shall be convey to the public when deemed appropriate to enable an understanding of issues, concerns, and solutions for Integrated CCS in Kansas, *ICKan*. A focused dialog with interested stakeholders shall be sought through informational meetings and workshops that correspond with formal reporting to DOE including intermediate results and the final report. Prior to the final report being released, the CCS team shall invite key stakeholders and interest groups to participate in addressing the general topics of CCS and to comment on the plan and strategy through a conference and workshop in order build public support for taking the next steps in ICKan.

Subtask 7.3 - Publications
The CCS team shall publish methodologies, findings, and recommendations.

D. DELIVERABLES

Reports will be submitted in accordance with the attached “Federal Assistance Reporting Checklist” and the instructions accompanying the checklist.

In addition to the reports specified in the "Federal Assistance Reporting Checklist", the Recipient will provide the following to the DOE Project Officer.

Data Submitted to NETL-EDX
Data generated as a result of this project shall be submitted to NETL for inclusion in the NETL Energy Data eXchange (EDX), https://edx.netl.doe.gov/. The Recipient will work with the DOE Project Officer to assess if there is data that should be submitted to EDX and identify the proper file formats prior to submission. All final data generated by this project shall be submitted to EDX including, but not limited to: 1) datasets and files, 2) metadata, 3) software/tools, and 4) articles developed as part of this project.

Other key deliverable include:

- Task 1.0–Project Management Plan
- Task 1.10 – Technical report on *Integrated Strategy For Commercial-Scale CCS Project*
- Task 2.0 – Commitment letters from fully formed *CCS Coordination Team*
- Task 3.0 – Technical report on *Plan to Address Challenges of the Commercial-Scale CCS Project*
- Task 4.0 – Technical report on *High-Level Sub-Basinal Evaluations*
- Task 5.0 – Technical report on *High-Level CO_2 Source Assessment for Capture*
- Task 6.0 – Technical report on *High-Level Assessment for CO_2 Transportation*
- Initial Business Plan that describes the selected source, capture technology, transportation route, and injection site(s), in a saline aquifer, with anticipated surface and subsurface infrastructure requirements. Additionally, a data gap analysis should be performed and include a discussion on the missing data and how the identified data gaps will be filled. There should be a discussion on non-technical issues such as outreach, political aspects of the project, legal requirements such as pore space ownership, permitting requirements, and the ownership of the CO_2/liability throughout the process of capturing, transportation and injection. An economic analysis should be performed that includes anticipated costs for filling in data gaps, anticipated capital expenditures, construction costs, and future system operational expenditures for the proposed CCS system. There should be a list of anticipated sources of funding and strategies to pay for the installation and the operation of the CCS system. The business plan should also have discussions on how the costs of oil will affect the financing of the project and at what price point will it be economically feasible.

E. BRIEFINGS/TECHNICAL PRESENTATIONS

The Recipient shall prepare detailed briefings for presentation to the Project Officer at a location(s) to be designated by the Project Officer, which may include the Project Officer's facility located in Pittsburgh, PA or Morgantown, WV. The Recipient shall make a presentation to the NETL Project Officer/Manager at a project kick-off meeting held within ninety (90) days of the project start date. At a minimum, annual briefings shall also be given by the Recipient to explain the plans, progress, and results of the technical effort and a final project briefing prior to the close of the project shall also be given.

The Recipient shall also provide monthly E-mail updates on the status of the project to the FPM.

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Accomplishments

Task 1.0 – Project Management and Planning Integrated CCS for Kansas

Subtask 1.1 - Fulfill requirements for National Environmental Policy Act documentation

Completed in Q1.

Subtask 1.2 - Conduct a kick-off meeting to set expectations

Completed in Q1.

Subtask 1.3 - Conduct regularly scheduled meetings and update tracking

KGS Team Meetings:
Team meetings were held monthly. Topics focused primarily on technical updates for identifying geologic sites and planning for the wrap-up session in July. Frequent individual meetings are held on an as-needed basis throughout the course of the reporting period.

Full Team Meeting:
The all team Quarterly meeting was held 4/12/2018. Agenda cover the project status, updates regarding the Phase II proposal, work remaining to complete, scheduling, and discussing the "all hands" wrap-up session.

Other:
The KGS introduced the team to Battelle and other Phase II participants. Notification that Phase II was awarded to the KGS and Battelle was shared mid-May.

Subtask 1.4 - Monitor and control project scope

The KGS held regular monthly and bimonthly meetings with the team to discuss the status of deliverables and evaluate tasks. Participants provided a brief overview of their work and discussed steps forward.

Subtask 1.5 - Monitor and control project schedule

The project schedule was reviewed during monthly and bimonthly meetings with the team.

Subtask 1.6 - Monitor and control project risk

Risks were evaluated in an ongoing basis within normal workflow. Larger concerns were presented in team meetings where in-depth discussions could be held.

Subtask 1.7 - Finalize the DMP.

Completed in Q3.

Subtask 1.8 - Revisions to the PMP after submission

Nothing to report.

Subtask 1.9 - Develop an integrated strategy/business plan for commercial scale CCS

This topic was discussed in follow up meetings to prepare for Phase II. New collaborations and partnerships were formed as the group established stakeholders. Work is ongoing.

Task 2.0 – Establish a Carbon Capture and Storage (CCS) Coordination Team

The Integrated CCUS for Kansas and Nebraska Integrated Carbon Capture and Storage Pre-Feasibility Study, led by Energy & Environmental Research Center, Phase I projects joined Battelle Memorial Institute's Integrated Mid-Continent Carbon Stacked Storage Hub (DE-FE0029264), in a single CarbonSAFE Phase II proposal. Possible gaps in the CCS coordination team for the combined project were identified in a December 5, 2017 meeting of the three projects in held in Lincoln, Nebraska, and in subsequent conference calls. ICKan secured additional industry partners and stakeholder as well as commitments from key Phase I partners.

Subtask 2.1 - Identify additional CCS team members

Completed in Q3-Q4.

Subtask 2.2 - Identify additional stakeholders that should be added to the CCS team

Completed in Q3.

Subtask 2.3 - Recruit and gain commitment of additional CCS team members identified

Completed in Q3.

Subtask 2.4 - Conduct a formal meeting that includes the Phase I team and committed Phase II team members

This is no longer applicable as defined in the proposal because ICKan joined Battelle and EERC in a Phase II proposal. However, a full ICKan project meeting will be held in Q4 that will include all ICKan Phase I participants as well as newly recruited industry partners and stakeholders.

Significant activities and accomplishments in the reporting period for Task 2 include the following:

- Awarded Phase II funding for project titled Integrated Midcontinent Stacked Carbon Storage Hub, announced on May 24, 2018. DOE Funding: $9,637,962; Non-DOE Funding: $3,701,000; Total Value: $13,338,962. This project combines three Phase I projects led by the KGS, Battelle and EERC. Battelle is the lead on the Storage Hub project.

Goals and objectives for the next Quarter:

In Q6 the ICKan project will conduct an "all ICKan project" meeting that will also include new Phase II partners and stakeholders.

Products for Task 2.0:

No physical products for Q5.

Task 3.0 – Develop a plan to address challenges of a commercial-scale CCS Project

Subtask 3.1 - Identify challenges and develop a plan to address challenges for CO2 capture from anthropogenic sources

A plan will be developed that addresses CO_2 capture, including use of plant configuration, current and anticipated operating conditions, product distribution (e.g. electrical power grid), and regulatory uncertainty.

The ICKan proposal presented three candidate sources for CO_2 capture. The objective of Phase I work is to determine which are most feasible, and to identify and develop a preliminary plan to address the unique challenges of each source that may be feasible for commercial-scale CCS (50+ million tonnes captured and stored in a saline aquifer). Although no time frame was defined by FOA15824 for the processing of 50 million tonnes, the ICKan project set 2.5 million tonnes/year over a 20-year period as a target.

Summary of Activities:
None to report.

Significant Results/Key Outcomes:
None to report.

Goals and objectives for the next Quarter:
During the next quarter, capture cost estimates will be completed and the team will integrate the costs for capture into the integrated project economics.

Products for Subtask 3.1:
None to report.

Subtask 3.2 - Identify challenges and develop a plan to address challenges for CO_2 transportation and injection (non-technical)

Subtask 3.3 - Identify challenges and develop a plan to address challenges for CO_2 storage in geologic complexes (non-technical)

Note - The SOPO combined technical and non-technical aspects of the Phase I project in Task 3, in particular Subtasks 3.2 and 3.3. To simplify for reporting and for the reader, the technical and non-technical are discussed separately. Furthermore, the non-technical subject matter pertaining to Subtasks 3.2 and 3.3 have considerable overlap and will be combined for this and future reports.

<u>**Subtasks 3.2 and 3.3 Non-Technical Section:**</u>

Overview
The ICKan Legal, Regulatory and Public Policy team (LRPP), is comprised of attorneys from Depew Gillen Rathbun & McInteer (DGRM), public policy experts from Great Plains Institute and the Kansas Geological Survey outreach manager. In this quarter LRPP continued their dialogues with State and Federal regulators and agencies, worked towards a better understanding of Class VI wells, and developed a preliminary plan to address business and contractual requirements to address technical and financial risks.

Significant activities and accomplishments in the reporting period for Subtasks 3.2 and 3.3 include the following:

1. Continued discussions with the Kansas Corporation Commission.
2. Participated in planning for ICKan all team meeting and CCUS in Kansas conference, July 26.

Goals and objectives for the next Quarter (non-technical)**:**

- Present summary of results of non-technical part of Subtasks 3.2 and 3.3 in all-team meeting on July 26.

Products for Subtasks 3.2 and 3.3 (non-technical)**:**

- Summary of meeting with Kansas Corporation Commission, Transportation and Utilities Division (Below)

Summary of meeting with Kansas Corporation Commission, Transportation and Utilities Division

On May 29, 2018 Susan Stover, KGS, Martin Dubois, IHR LLC, Chris Steincamp and Joe Schremmer, DGR&M, met with Jeff McClanahan, Director, Leo Haynos, Head of Pipeline Safety, Justin Grady, Chief Economist, and legal counsel Amber Smith, all with the Utility Division, Kansas Corporation Commission. We updated KCC on the CarbonSAFE study and new developments (45Q, Phase II study with Battelle).

KCC expressed their concern on the cost of installing and using carbon capture equipment on coal-burning electrical plants. The Utilities Division has the option to pre-determine any rate-payer impact with carbon-capture equipment. The retail dispatch of the least expensive energy means that the coal units contribute last, after wind and nuclear (Wolf Creek). With increasing energy efficiencies, and as wind continues to capture more of the energy markets (additional wind farms are expected to come online in Kansas over the next couple years), the coal-unit costs grow relatively more expensive with less use. Kansas' coal-fired plants already have significant economic pressure, generating excess capacity (in excess of $3.3 billion). Renewables and nuclear power alone cannot meet all the demands; the coal-burning electrical plants are needed to meet total energy demands and cover the gaps when the wind isn't blowing. McClanahan is supportive of programs that can keep the coal-burning units viable; currently, the economics put them at a disadvantage over renewables, even without the carbon capture equipment. A comprehensive, national energy plan could help solve market pricing contradictions. Given the current economics, Director McClanahan cannot see how they could recommend the cost of adding carbon capture equipment.

We also discussed pipelines and the options for a CO2 pipeline as a public utility, which would give it eminent domain authority. A pipeline could qualify as a public utility if it affects the public supply.

<u>**Subtasks 3.2 and 3.3 Technical Section:**</u>

Subtask 3.2 - Identify challenges and develop a plan to address challenges for CO2 transportation and injection *(Technical)*

The likely mode of transportation for large-scale CCS is via pipelines. Because of the long history (40+ years) of CO2 transportation, and even a longer history of transporting high pressure natural gas, there are no significant technical challenges to transporting CO2 via pipelines. Non-technical challenges are covered separately.

Summary of significant activities:
None to report.

Significant Results/Key Outcomes:
None to report.

Goals and objectives for the next Quarter:
None to report.

Subtask 3.3- Identify challenges and develop a plan to address challenges for CO2 storage in geologic complexes *(Technical)*

Summary of significant activities:
None to report.

Significant Results/Key Outcomes:
None to report.

Goals and objectives for the next Quarter:
None to report.

Task 4.0 – Perform a high level technical sub-basinal evaluation using NRAP and related DOE tools

Subtask 4.1 - Review storage capacity of geologic complexes identified in this proposal and consider alternatives

In the proposal we identified three possible sites in two complexes that were in various stages of analysis and each appeared to meet the 50+Mt storage requirement. Post award, they were to be evaluated further and a survey of other potential geologic structures were to be screened and evaluated for suitability.

Overview:

Two geologic complexes identified in the initial proposal as potential sites for storing >50 million tonnes (Mt) are the Pleasant Prairie field geologic site, considered the primary storage site, and the Davis Ranch and John Creek fields, in the Forest City Basin (FCB) storage complex, considered a secondary site. Preliminary capacity evaluation for the FCB indicated it not capable of storing >50Mt CO2 (Q1 ICKan report). In the process of evaluating the Pleasant Prairie site, four separate geologic structures were identified as each having potential for storing 50Mt. The four structures, aligned on the same regional geologic structure, are similar in size, have >100 ft of closure, and similar geologic histories. The four potential sites, Rupp, Patterson, Lakin and Pleasant Prairie are in what we have named North Hugoton Storage Complex (NHSC) [Figure 1]. CO2 injection simulation studies are now complete for the Lakin (reported in Q2 ICKan report) and the four structures in Figure 1, Pleasant Prairie, Lakin, Patterson, and Rupp. The Patterson site has been determined to be the primary site for a Phase II storage site and the other three sites in the NHSC will be considered alternative sites. Preliminary reports for the Lakin and Patterson sites were provided in prior quarterly reports. This report covers the Pleasant Prairie site and, to a lesser extent, the Rupp site.

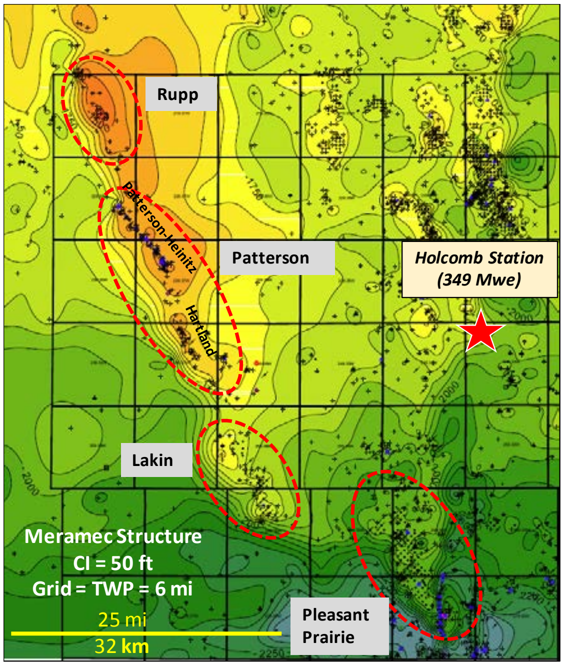


Figure 1. Location of four plausible storage sites within the North Hugoton Storage Complex. Map is the structure on the top of the Meramec (Mississippian). Patterson is the primary site and the others are alternative sites.

Summary of significant activities:

- The Pleasant Prairie site preliminary technical report was compiled.
- A brief summary of the Rupp site simulation was compiled.

Significant Results/Key Outcomes:

- A high-level evaluation of the storage capacity and injectivity in saline aquifers beneath the Pleasant Prairie site indicating a storage capacity is in excess of 50Mt. See discussion of modeling and simulation results under Subtask 4.2.
- Two of four storage sites in the NHSC are each likely to be capable of storing >50Mt CO2, Pleasant Prairie and Patterson (Table 1). Initial, simple simulations in two sites demonstrate less than 50Mt capacity (Rupp and Lakin), however, it is believed both could store >50Mt if simulations were optimized.

Storage Complex	Geologic Site	Volume Stored (Mt)	Injection Wells	Years of Injection	Comments
North Hugoton	Rupp	36.6	4	30	Likely to exceed 50 Mt
	Patterson	60.7	4	30	> 50 Mt minimum
	Lakin	30.8	3	25	Likely to exceed 50 Mt
	Pleasant Prairie	67.4	3	25	> 50 Mt minimum
Forest City Basin	Davis Ranch - John Creek	24.6	6	25	Cannot meet 50Mt minimum

Table 1. Summary of CO2 injection simulations performed at five geologic sites considered. The

Patterson site is considered the primary injection site for Phase II, and the Rupp, Lakin and Pleasant Prairie sites are alternatives.

Goals and objectives for the next Quarter:

- The primary goal for the following quarter is to complete final technical reports for all geologic sites modeled.

Products for Subtask 4.1:

- Preliminary technical report for the Pleasant Prairie site.
- Summary of injection simulation results for the Rupp site.

Subtask 4.2 - Conduct high-level technical analysis of suitable geologic complexes using NRAP- IAM-CS and other tools for integrated assessment

The KGS shall evaluate candidate storage complexes in terms of capacity, seal, faults, seismicity, pressure, existing wellbores, and injectivity.

Summary of significant activities:
Table 2 summarizes activities and work completed by the ICKan technical team related to Subtasks 4.1 and 4.2.

Storage Complex	**North Hugoton**				**FCB**
Geologic Site	**Rupp**	**Patterson**	**Lakin**	**Pleasant Prairie**	**Davis Ranch - John Creek**
umetric Capacity					
Data gather and process	complete	complete	complete	complete	complete
Well log anslysis and tops	complete	complete	complete	complete	complete
Petrophysics	complete	complete	complete	complete	complete
2D models	complete	complete	complete	complete	complete
3D models	complete	complete	complete	complete	complete
Volumetric (capacity)	complete	complete	complete	complete	complete
Simulate for injectivity	complete	complete	complete	complete	complete
hnical Risks					
Seals - geochemistry	complete	complete	complete	complete	complete
Seals - petrophysical	NA	partial (Q6)	NA	partial (Q6)	NA
Fault leakage	NA	Q6	NA	partial (Q6)	NA
Seismicity	NA	Q6	NA	Q4	NA
Wellbores	NA	Q6	NA	NA	NA
lementation Plan					
Injection plan	NA	Q6	NA	NA	NA
Monitor plan	NA	Q6	NA	NA	NA

Table 2. Summary of technical analysis activities and work completed on potential geologic sites. Shaded entries are work completed in the quarter covered by this report. “Partial” indicates work begun, but not completed in Q3. Q4 or Q4,5 indicates the project quarter in which the specific work is to be completed. NA indicates analysis that will not be completed because the site is an alternative site or the sites was determined incapable of storing 50Mt CO_2.

Significant Results/Key Outcomes:

Key outcome 1: Pleasant Prairie site high-level technical analysis (capacity, injectivity, seals)

The high-level technical analysis of the Pleasant Prairie confirms that it is capable of storing in excess of 50Mt injected over a 25-year period. The simulation documented in this report indicates that at least 67.4 Mt could be injected into three wells and stored within the three target zones (Osage, Viola, and Arbuckle).

Setting

The Pleasant Prairie site is situated in southwest Kansas at the northern end of the giant Hugoton Gas Field and is part of the NHSC (Figures 1 and 2). Four geologic sites in the NHSC are on a prominent northwest-southeast structural trend, have the same geologic history, and the same saline aquifer reservoirs beneath them. Three stratigraphic intervals are considered for CO2 storage, the Mississippian Osage, Middle-Ordovician Viola, and Cambro-Ordovician Arbuckle (Figure 3). All three have regional lateral extent and appear to be separated by vertical barriers to fluid migration (Spergen, Kinderhook, and Simpson dense carbonate and thin shales). The Morrow shale (Pennsylvanian) on top of the Meramec (Mississippian) is a regional top seal for the oil and gas accumulations in the Mississippian.

Saline aquifer reservoirs in the Osage and Viola consist of thick (>100ft), vertically continuous, laterally extensive porous carbonate, primarily medium-crystalline sucrosic dolomite with good intercrystalline porosity and varying amounts of chert. The Arbuckle storage reservoir consists of stacked thin beds of porous dolomite over the 570-foot-thick Arbuckle, separated by thin intervals of tight carbonate. Although the relatively thin Arbuckle reservoirs do not appear to be well- connected vertically, drill stem tests in the Arbuckle, albeit limited in number, prove otherwise having fluid recoveries averaging over 2000 feet of saltwater in one-hour flow tests.

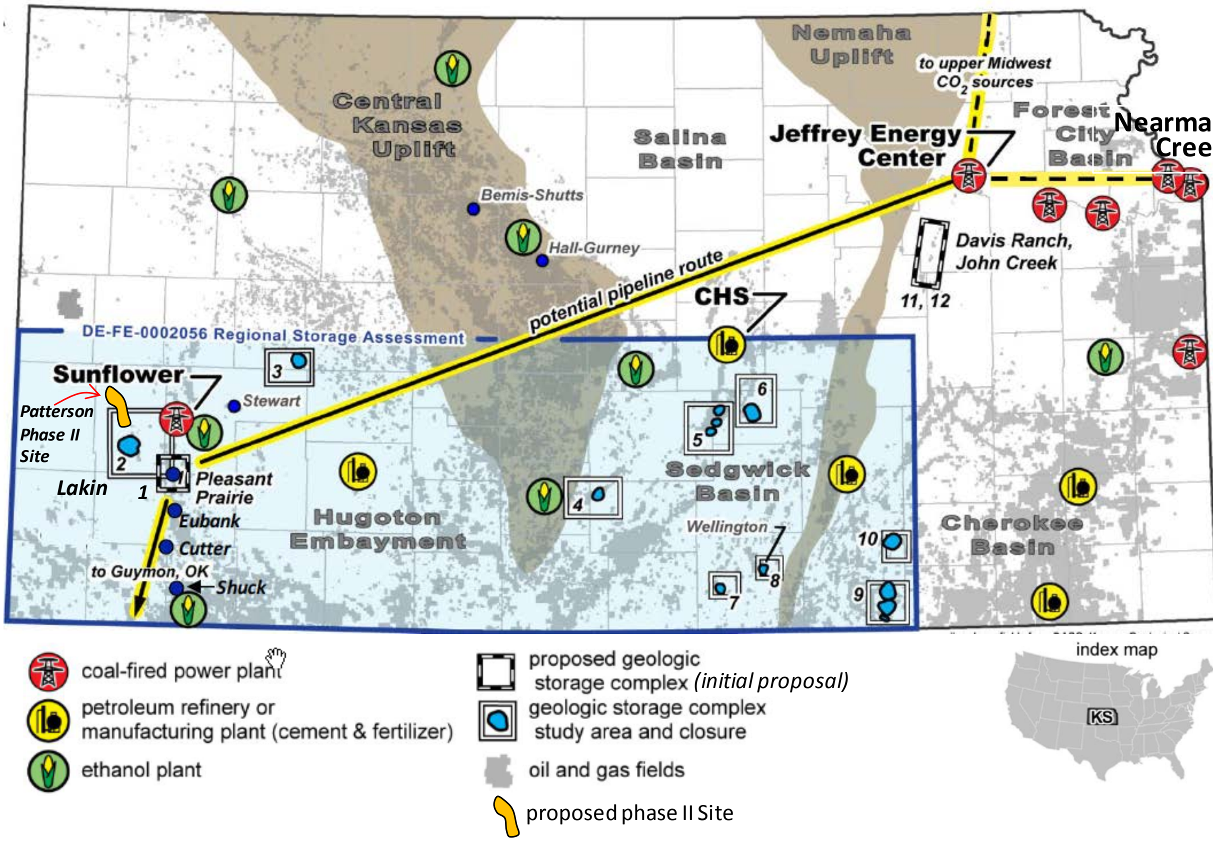


Figure 2. Kansas map showing location of the Pleasant Prairie site, other possible CO_2 injections sites (numbered 1-12), CO_2 sources, possible CO2 pipeline routes, DE-FE0002056 study areas (blue), and oil fields. (Figure modified from ICKan proposal SF 424 R&R, 2016).

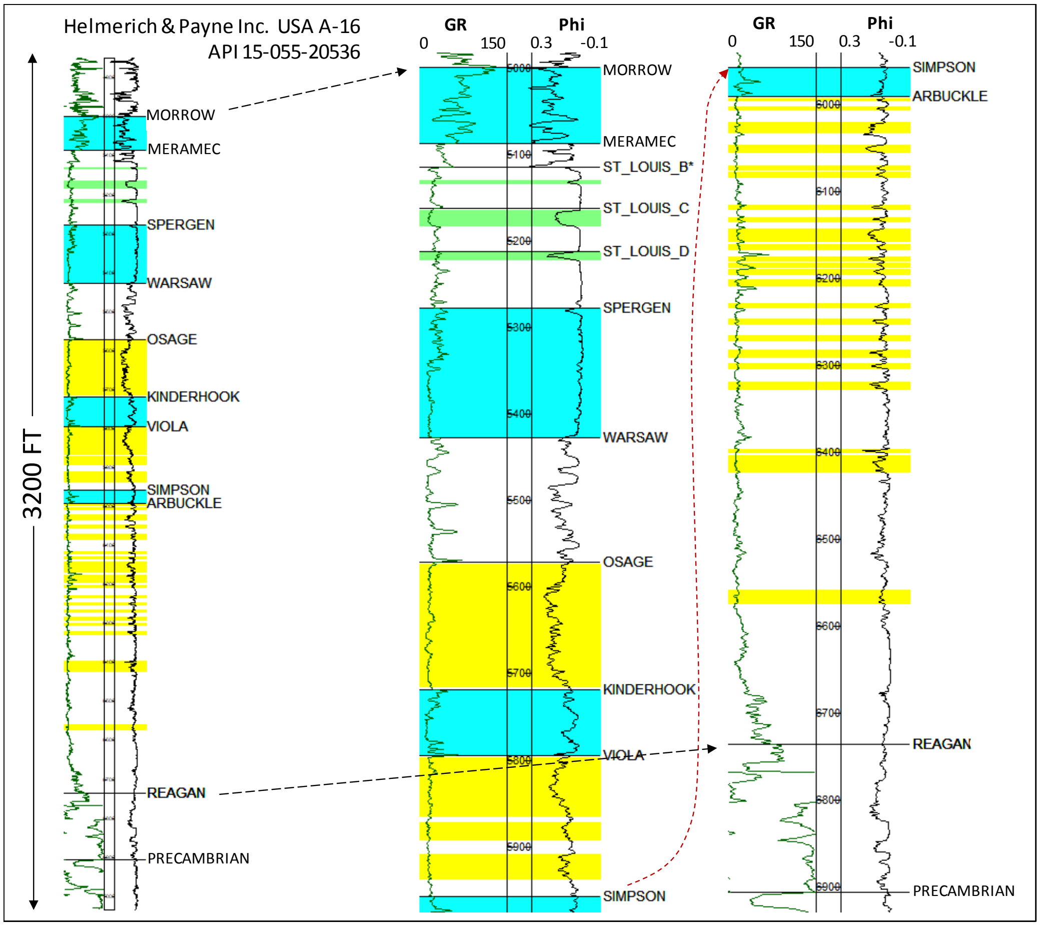


Figure 3. Generalized stratigraphic column for the Pleasant Prairie site area. Wireline log of a key well in the Pleasant Prairie site, the Helmrich & Payne USA A-16 well. Small-scale log on the left starts above the Morrow and extends into the Precambrian to TD (below surface casing to TD (4860-7030). An enlarged section of the well log is on the right. Porosity >8% is shaded yellow in the storage units and green in the St. Louis oil reservoirs. Caprocks and seals are shaded blue.

3D static model

Workflow

A simple, un-faulted 3D static model was built for a 202 mi^2 (520 km^2) area and then a smaller area was cut out of the model for simulation (Figure 4). A conventional workflow for building a 3D static model was deployed: 1) gather, prepare and analyze well-scale well data from public sources and operator-partner data, 2) build 2D structure and isopach maps utilizing 3D seismic and well tops in Geoplus Petra^{TM}, 3) import structural grids for horizons in geomodel constructed in using the structure maps as horizons in the static model in Petrel^{TM}, 4) populate cellular geomodel with porosity using sequential gaussian simulation by zone utilizing digital well log data, 5) develop petrophysical relationships to estimate permeability knowing porosity, 6) resulting in a large-area 3D static property model populated with porosity and permeability from the top of the Meramec to the base of the Arbuckle (Figure 5), 7) upscale the model to reduce cell counts for simulation, and 8) cut out and export smaller field-scale model for simulation.

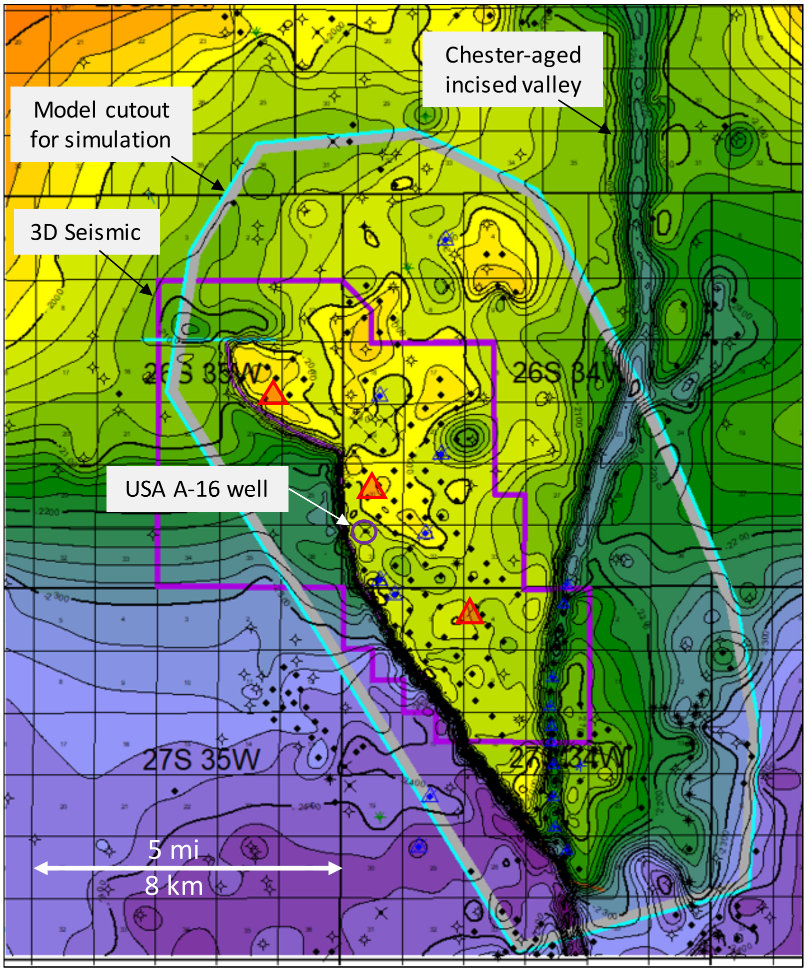


Figure 4. Plat of the Pleasant Prairie modeled area. Structure contours are on the top of the Meramec erosional surface, CI = 20 ft, based on 3D seismic (purple polygon) and approximately 450 well penetrations. The simulation model was cut out of the static model (blue polygon) and the three hypothetical injection wells are shown as triangles. The grid lines are one-mile sections.

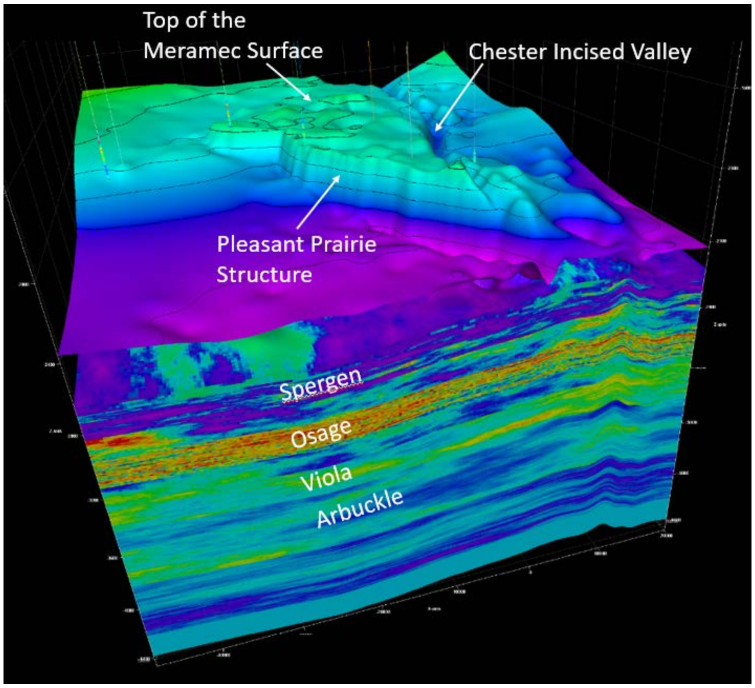


Figure 5. Two-hundred mi^2 static model displaying porosity from the Spergen to the base of the Arbuckle in fine-grid model before upscaling and cutting out a model for simulation. Warmer colors indicate higher porosity.

Well data

There are 444 wells deeper than 4,500 ft in the model area (Figure 6) and approximately 600 shallow wells (<4500 ft), the vast majority being shallow gas wells with depths under 3200 feet. The shallow gas wells are completed in the Chase and Council Grove Groups and are part of the shallow Hugoton-Panoma gas field.

Of the 444 deep wells, 412 penetrated the top of the Meramec, but very few penetrated the prospective saline storage zones, Osage, Viola, and Arbuckle. This is because because there is no oil or gas production below the upper 150 feet of the Meramec. Raster log images are available for most wells in the immediate vicinity of the simulation model and formation tops were picked for wells with penetrations below the Meramec. Only 12 wells penetrated the Warsaw, 7 wells penetrated the Osage, 5 cut the Viola and Arbuckle and only one well penetrated the Precambrian (Table 3). Only six of these wells had modern log curves, having a minimum neutron and density porosity and gamma ray, were either obtained from the KGS database or were digitized and used in the modeling process (Table 3 and Figure 6). Although the data is sparse, porous intervals in the three candidate injection zones, Osage, Viola, and Arbuckle) and the non-permeable intervals comprising the caprocks (Morrow, Spergen, Kinderhook, and Simpson) are laterally extensive.

Stratigraphic Name	Penetrations - All Wells	Model Digital Logs
Meramec	412	
Spergen	88	6
Warsaw	12	5
Osage	7	3
Viola	5	2
Arbuckle	5	2
Precambrian	1	1

Table 3. Well penetrations by stratigraphic interval and modern digital logs available for geologic modeling in the Pleasant Prairie model area.

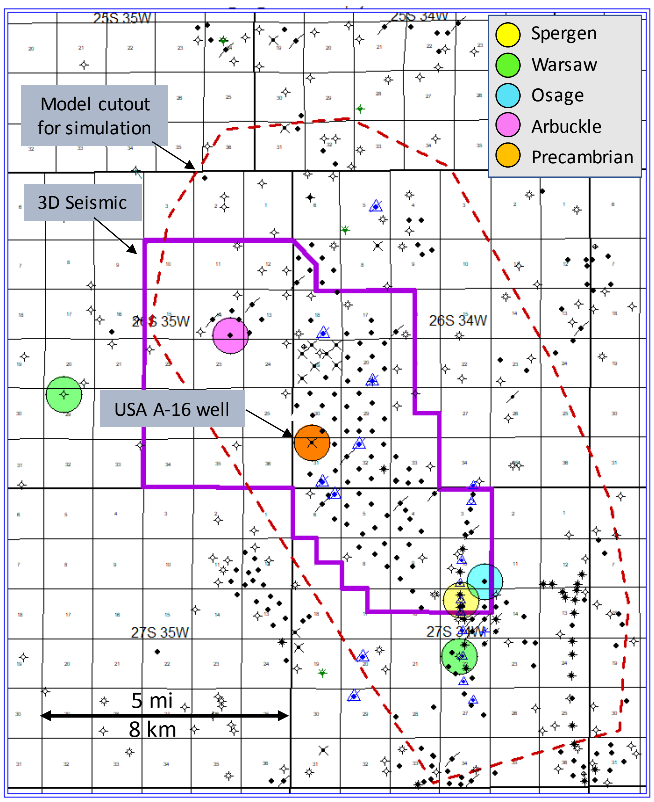


Figure 6. Plat of the Pleasant Prairie modeled area with wells >4500 ft TD. Six wells with usable modern digital well logs are color coded by deepest penetrations.

Petrophysics

Porosity input for the geomodel was the average of neutron and density porosity and gamma ray at the half-foot scale for the 6 wells with modern logs (Table 3 and Figure 6) from the Morrow to total depth. Permeability was calculated in the geomodel using porosity-permeability transform equations derived from available empirical data.

Estimating permeability for in the Pleasant Prairie is constrained by the lack of core data in the key saline aquifer reservoirs and sealing caprock intervals. The nearest set of core data for the key intervals is from the Berexco KGS-Cutter 1 well, approximately 25 miles south of the Lakin Field (Watney, et al., 2015). In the KGS-Cutter well, portions of the key intervals, Osage, Kinderhook, Viola, Simpson, and to a greater extent Arbuckle, have extensive core petrophysical data as well as an NMR log.

A fairly simple, straightforward approach was taken for obtaining porosity-permeability transforms for wells with modern digital well logs, triple-combo type logs, suitable for Techlog's multi-mineral analysis and porosity estimation.

1. Derive Coates permeability from NMR logs in the Cutter-KGS 1 well for intervals from the Spergen through the Arbuckle.
2. Compare Coates permeability with core permeability for calibration - satisfactory.
3. Develop porosity-permeability relationships by cross-plotting and fitting a mathematical curve (K-Phi transform) (Table 4).
4. Apply the K-Phi transform to six wells with digital curves in the Lakin-Pleasant Prairie area having appropriate digital well logs in at least the uppermost saline aquifer candidate, the Osage.

Zone	Permeability from Porosity (and GR for Arbuckle)
Meramec	Kxy=87.768*Porosity**2.0923
Spergen	Kxy=212571*Porosity**4.377
Warsaw	Kxy=452218* Porosity **5.0603
Osage	Kxy=331.31* Porosity **2.9257
Kinderhook	Kxy=157.2* Porosity **2.1019
Viola	Kxy=4160* Porosity **3.2036
Simpson	Kxy=40647* Porosity **3.7804
Arbuckle	Kxy=1000000000*GR**(-4.84)*(Porosity**(9.37*(GR**(-0.486))))

Table 4. Porosity-permeability transforms derived from empirical data utilized in the Pleasant Prairie geomodel.

Simulation model

Dynamic Modeling of CO_2 Injection at Pleasant Prairie Field

The key objectives of the dynamic modeling were to determine the volume of CO2 stored, resulting rise in pore pressure and the extent of CO2 plume migration in the Pleasant Prairie filed structure. Simulations were conducted using the Computer Modeling Group (CMG) GEM simulator, a full equation of state compositional reservoir simulator with advanced features for modeling the flow of three-phase, multi-component fluids that has been used to conduct numerous CO2 studies (Chang et al., 2009; Bui et al., 2010).

<u>Initial reservoir conditions and simulation constraints</u>

The initial conditions specified in the reservoir model are specified in Table 5. The simulations were conducted assuming isothermal conditions. Although isothermal conditions were assumed, a thermal gradient of 0.008 °C/ft was considered for specifying petrophysical properties that vary with layer depth and temperature such as CO2 relative permeability, CO2 dissolution in formation water, etc. The original static pressure in the injection zone was set to reported field test pressures and the Arbuckle pressure gradient of 0.48 psi/ft was assumed for specifying petrophysical properties. Perforation zone was set at top 35 ft of in all three injection intervals: Osage, Viola, and Arbuckle. Injection rate was assigned according to maximum calculated based on well tests and reservoir properties. Boundary conditions were selected as open Carter-Tracy aquafer with leakage allowed.

Injection Interval	**Osage**	**Viola**	**Arbuckle**
Temperature	60 °C (140 °F)	61 °C (142 °F)	62 °C (144 °F)
Pressure	1,650 psi (11.38 MPa)	1,700 psi (11.5 MPa)	1,800 psi (11.72 MPa)
Max. BHP	2250 psi ()	2300 psi	2400 psi
TDS	100 g/l	140 g/l	180 g/l
Formation Top	5,580 ft	5,790 ft	6,000 ft
Formation Base	5,620 ft	5,960 ft	6,730 ft
Perforation Zone	110 ft	140 ft	150 ft
Injection Period		25 years	
Number of wells		3	
Injection Rate	4,220 T/day	960 T/day	2,015 T/day
Total CO_2 injected	38.5 MT	10.5 MT	18.4 MT

Table 5. Model input specification and CO_2 injection rates

Three wells were completed in the main part of the Pleasant Prairie structure and were "perforated" in the Mississippi Osage, Viola, and Arbuckle. No flow boundary conditions were specified above and below the injection zones as indicated by brine chemistry. Additional work is underway to support these assumptions. CO2 was injected at rates determined by the petrophysical conditions at each injection site and within each perforated interval. The lateral boundary conditions were set as an infinite-acting Carter-Tracy aquifer (Dake, 1978; Carter and Tracy, 1960) with leakage.

Simulation results

Figures 7 and 8 show the maximum lateral migration of the CO2 plume approximately 100 years after cessation of CO2 injection activities at Pleasant Prairie Field. The plume grows rapidly during the injection phase and is largely stabilized 20-30 years after the end of injection period. CO2 travels throughout the reservoir for additional several years and enters stabilization phase after several years post injection commencement. Significant amount of CO2 (~30%) is dissolved in water over the period of 50 years past injection commencement.

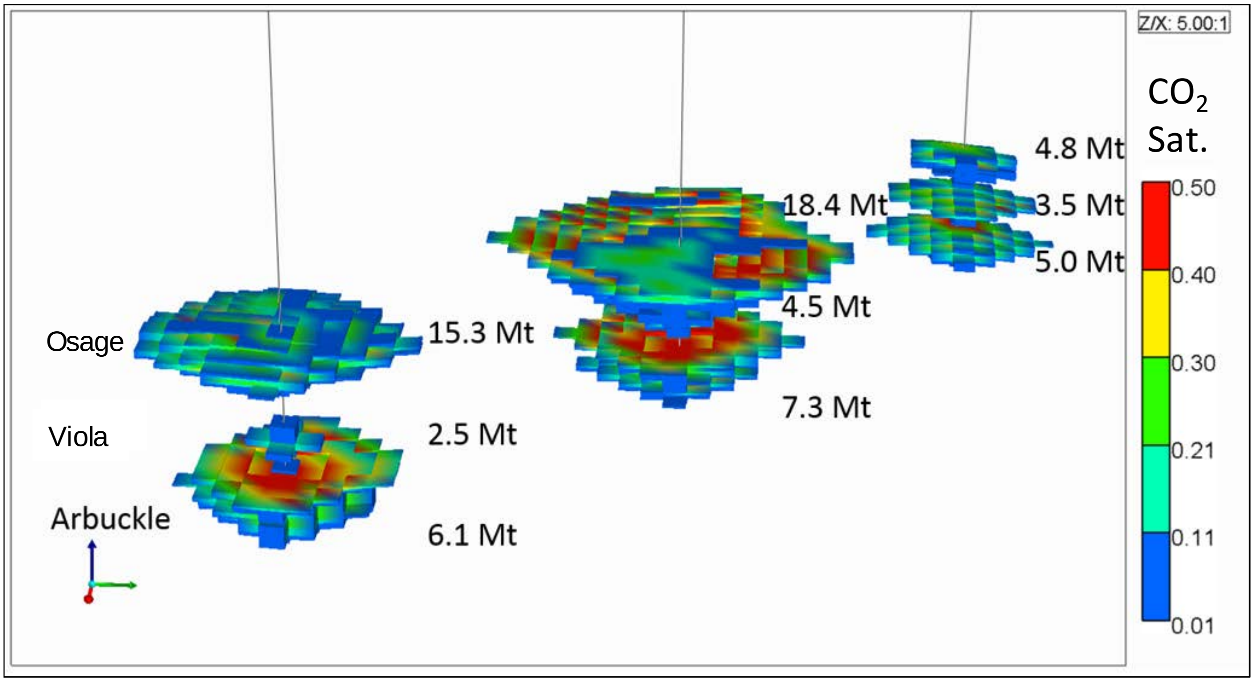


Figure 7. Dynamic simulation results showing CO2 plumes after vertically stacked injection in the Arbuckle, Viola, and Osage. A. 3D view of CO2 plumes in stacked saline aquifers with CO2 volume stored for each plume (million tonnes).

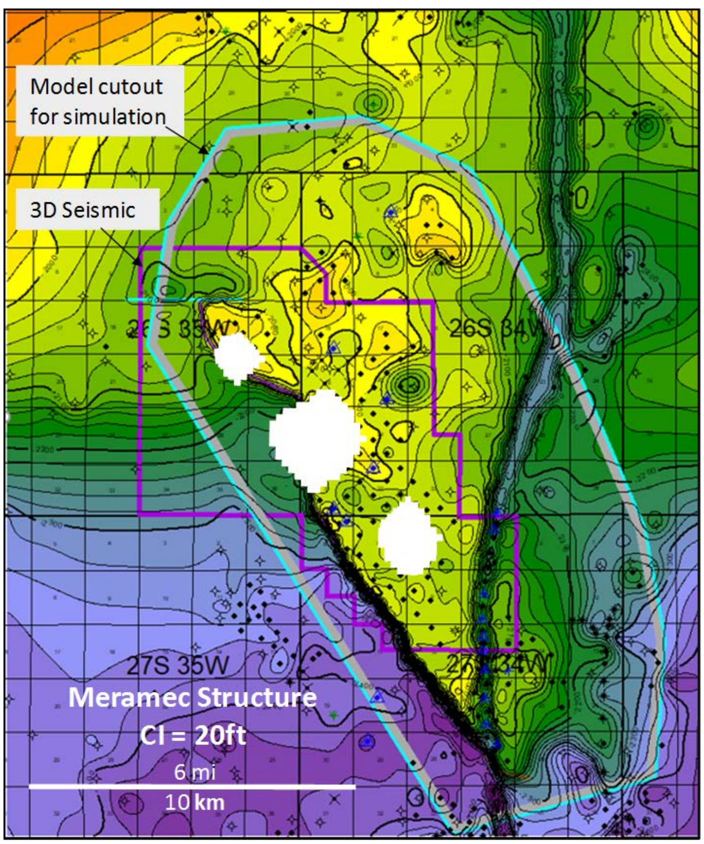
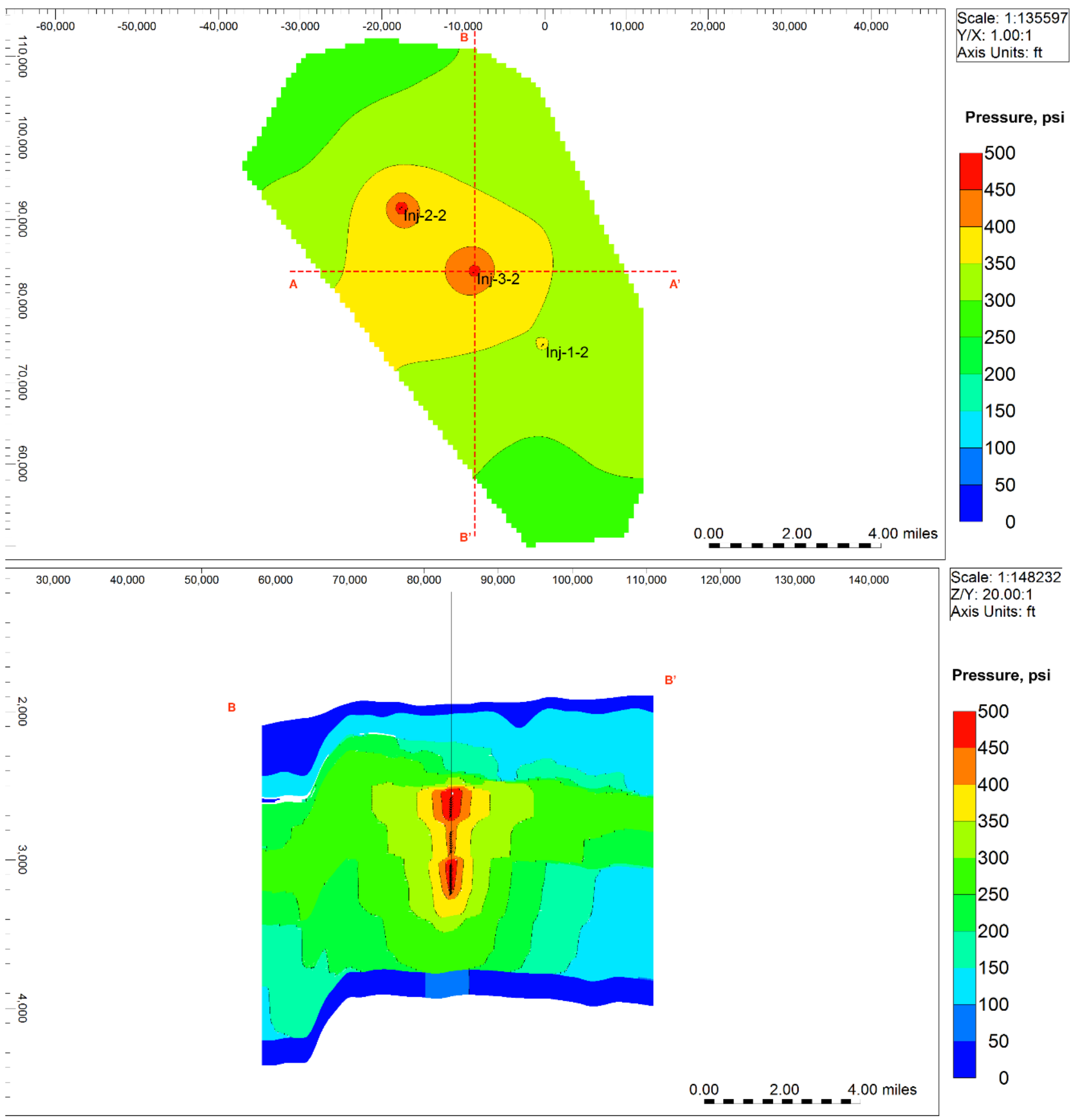


Figure 8. Plat showing aerial extent of plumes for the three injectors

Figure 10 presents the distribution of reservoir pore-pressure at the maximum point of CO2 injection. The pressure increases are estimated to be below 500 psi on commencement of injection and then pressure gradually drops after the commencement of the injection as the capillary effects are overcome. The pressure decreases to almost pre-injection levels after approximately 15-20 years as illustrated in Figure 11.

Figure 12 illustrates modeled cumulative injection volumes obtained via injection by 3 injection wells completed at Osage, Viola, and Arbuckle intervals. Maximum combined injection rate for 3 wells modeled for Pleasant Prairie Site is 7,195 metric tonnes/day. The cumulative injected CO2 estimate for the Pleasant Prairie Site is 67.4 million tonnes; however, the injection strategy could be optimized to inject even higher amount of CO2 at this site.



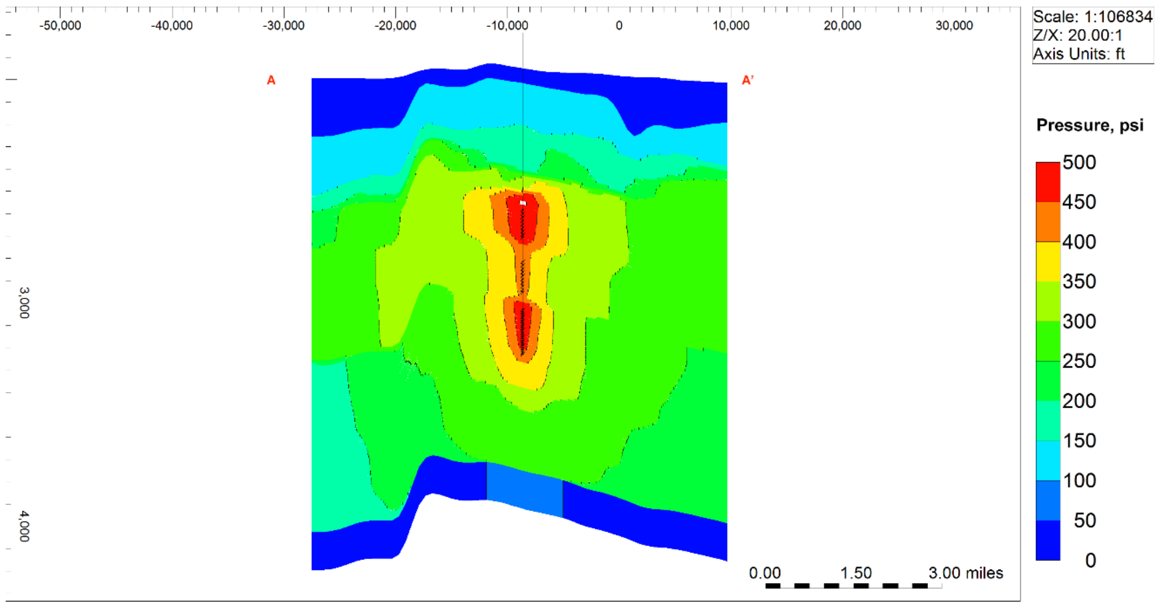


Figure 10. Maximum reservoir pressure increases as a result of CO_2 injection.

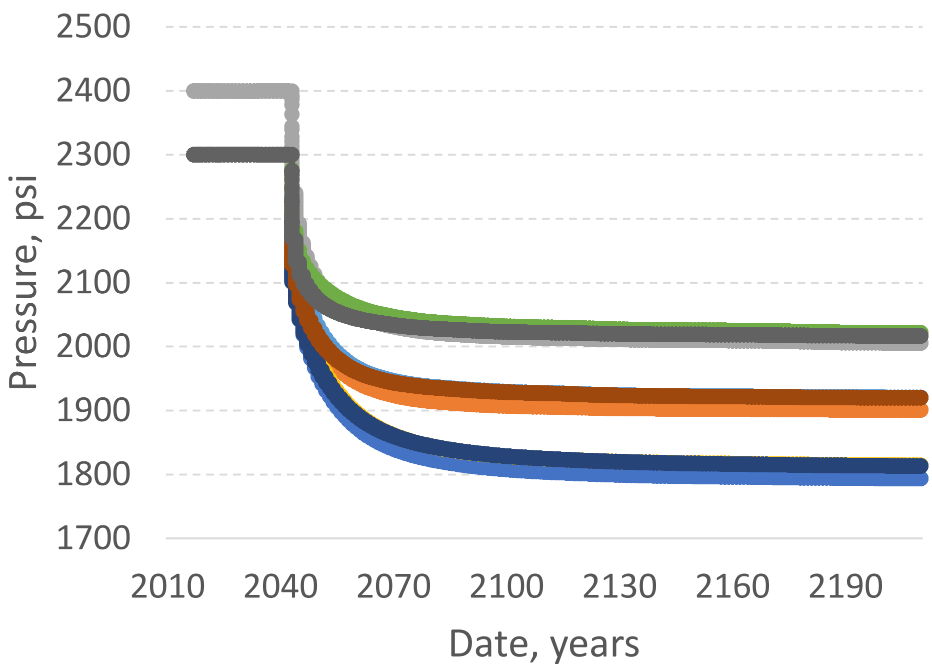


Figure 11. Bottom-hole pressure profiles for CO2 injection in three wells and three injection intervals.

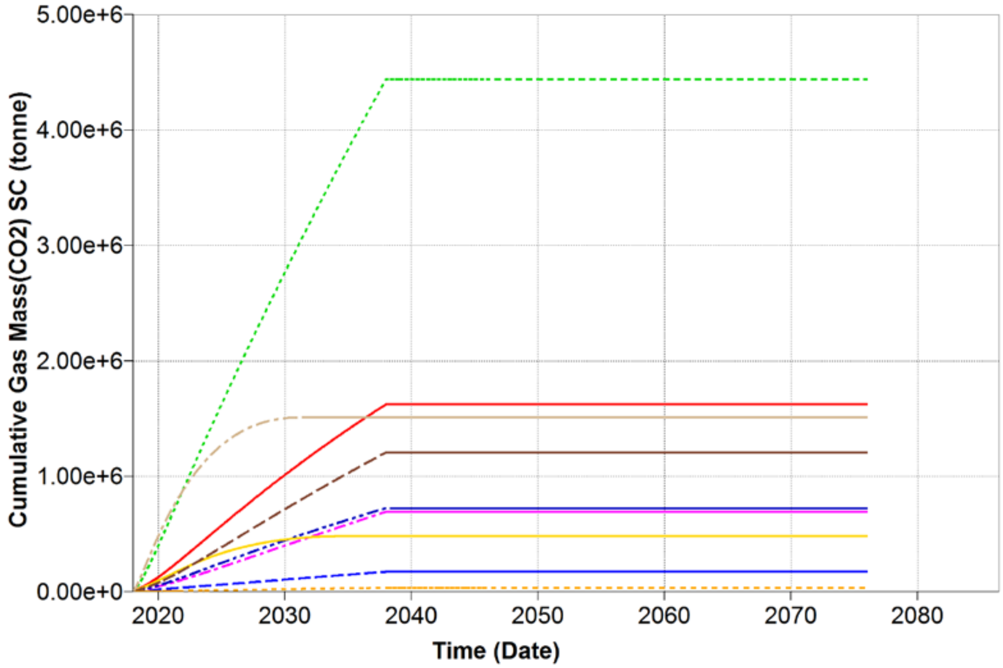


Figure 12. Cumulative CO2 injection volumes in three wells and three injection intervals.

<u>Summary/Discussion</u>

For CO2 injection simulations at the Pleasant Prairie site, three wells were placed in close proximity to the apex of the linear closed structure where there was higher porosity and permeability indicated in the 3D static model in the three storage zones, the Osage, Viola, and Arbuckle. A fully-compositional simulation using CMG Gem software was performed. Injection was restricted to a delta P of 600 psi above reservoir pressure and a maximum of 2400 psi in the Arbuckle, approximately equal to hydrostatic pressure and 2100 psi under fracture pressure (assuming 0.75 psi/ft). Daily injection rates were 2.6, 3.3, and 1.5 kilotonnes/day for 25 years, storing 67.4 tonnes. Maximum plume diameter averages 2.6 miles (4.2 km) 100 years after injection ceased.

Geochemistry

Comparison of salinities in the reservoirs at the Pleasant Prairie (Fig. 13) has utility for inferring the potential for cross-stratigraphic flow, or *leakage*, between reservoirs. Gradually increasing or similar salinity with depth regardless of apparently separate reservoir may indicate communication between reservoirs. Conversely, contrasts in the salinity of the waters in the principal reservoirs of the fields may indicate that the reservoirs are isolated from each other, in that drastic salinity contrasts would not be expected for reservoirs in close hydraulic communication. Salinity contrasts thus may assure that each reservoir will not readily leak when they are separately charged with CO_2. Salinity data was therefore examined for the Chester Mississippian, underlying Mississippian carbonates, Viola, Simpson, and Arbuckle reservoirs.

There are four basic sources of information on salinity: the Kansas Geological Survey on-line brine database, chemical analyses of produced water donated by oilfield operators, salinity analyses reported for water recovered in drill-stem tests, and salinity determined from geophysical well logs. For the Pleasant Prairie area, no operator-donated analyses were available.

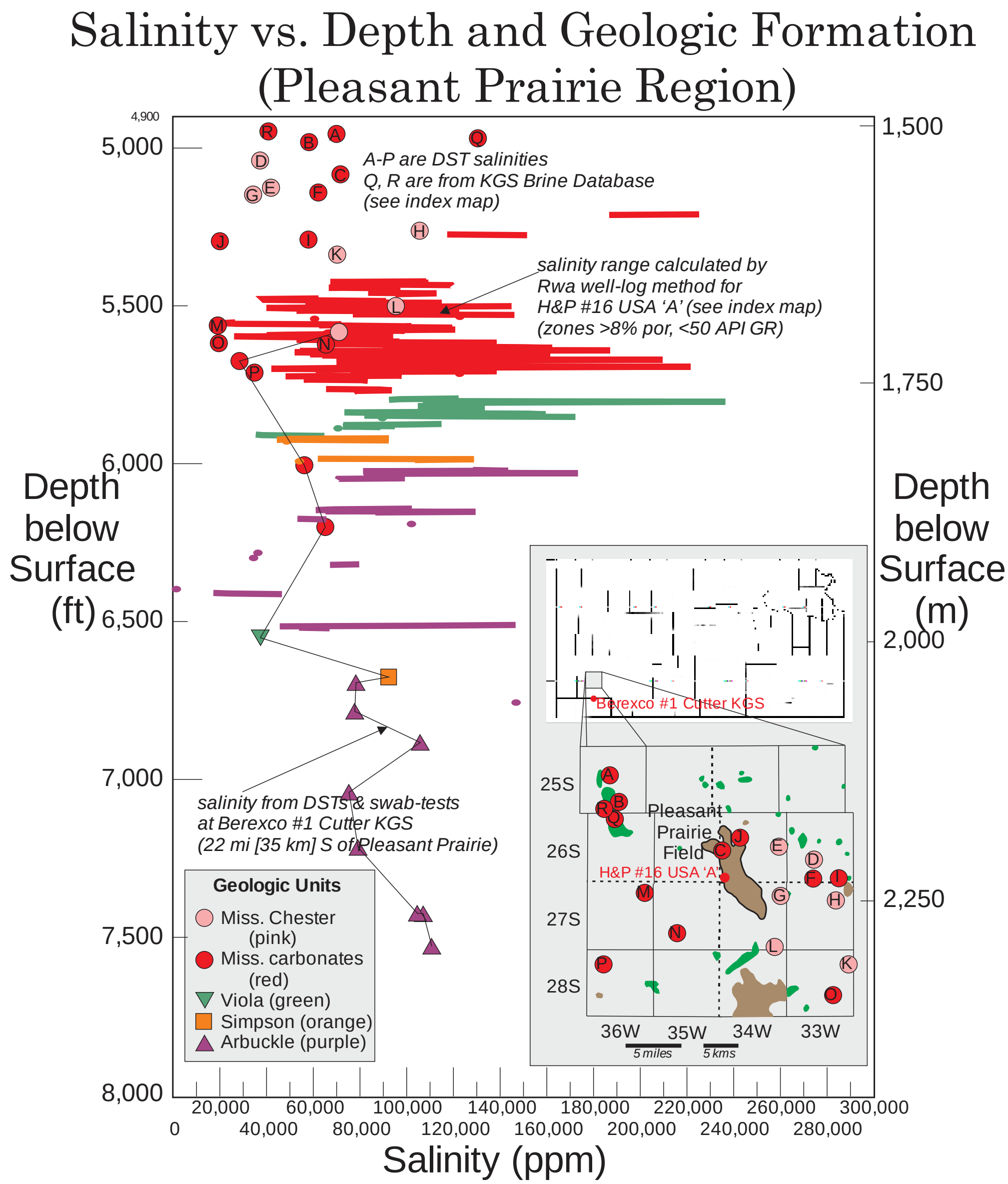


Figure 13. Salinity vs. depth of porous zones in the vicinity of Pleasant Prairie Field, southwestern Kansas. Measurements from swab tests and DSTs and production water are designated by geometric figures (circle, square, triangle) whereas calculated salinities from geophysical well logs are smaller dots and lines. Geologic formations are also color-coded.

Sixteen (16) analyses (A though P in Fig. 13) were from DST chlorinity and salinity field measurements. Scans of DST tests are available on-line at the Kansas Geological Survey website. Two (2) analyses (Q and R in Fig. 13) were available from the KGS on-line brine database. Salinity measurements from DSTs or swab tests from the KGS Cutter well, 22 miles to the south of Pleasant Prairie Field were available from DOE quarterly reports, via personal communication from Kansas Geological Survey scientist Mina Fazelalavi. The Cutter #1 well represents the nearest locality where these is a spread of salinity measurements over several geologic formations. The well-log resistivity method (Doveton, 2004) was employed to generate most of the salinity data.

The well-log resistivity method utilizes a rearrangement of the Archie Equation to determine the resistivity of formation water (Rw). Rw is then converted to a salinity measurement (Doveton, 2004). Input into the formula includes a porosity and resistivity measurements, usually averaged over a two-ft vertical interval. The porosity used is an average of the neutron and density porosity measurements. The resistivity measurement is that of the deep induction log, so as to measure resistivity away from the vicinity of the well bore, which is subject to the effects of drilling mud and mud filtrate. Reservoir intervals with >50 API gamma ray units were not used in the analysis (so the effects of shaliness could be avoided), nor were tight zones measured where porosity is <8%. Oil-bearing zones were ignored, so that any resistivity measured in any given reservoir would be due principally to that of the formation water.

The well-log salinity measurements at Pleasant Prairie were from the H&P #16 USA 'A' well. Porous carbonates in the Mississippian in this well show drastically varying salinity – from dense basinal brines approaching 200,000 ppm, to dilute brines with ~20,000 ppm salinity – over narrow depth ranges (< 100 ft). Although Upper Ordovician Viola water in the H&P #16 USA 'A' well is generally more saline that Mississippian water (Fig. 13), water from the deeper Middle Ordovician Simpson sandstones is less saline than the Viola. The deepest geologic formation examined – the Cambrian-Ordovician Arbuckle -- has varying salinity with depth. Several measurements in the Cutter well in the Arbuckle also show varying salinity.

The varying salinity with depth, both sharply within the Mississippian carbonates, and salinity varying between different formations at depth, indicates that there is likely no natural communication between waters in the various porous zones at Pleasant Prairie and Lakin. No susceptibility of natural leakage of sequestered CO_2 out of the Mississippian and deeper reservoirs is thus indicated, although impermeable beds between the porous units can be thin (i.e., < 10 ft).

Key outcome 2: Summary of injection simulation results for the Rupp site.

A characterization, 3D modeling and reservoir simulation study was completed for the Rupp geological site (Figure 1). Initial dynamic modeling resulted in 36.6 million tonnes could be injected into three wells over a thirty-year period in three saline storage zones, the Osage, Viola, and Arbuckle (Figure 14). The full Rupp technical report is slated to be completed in the next quarter.

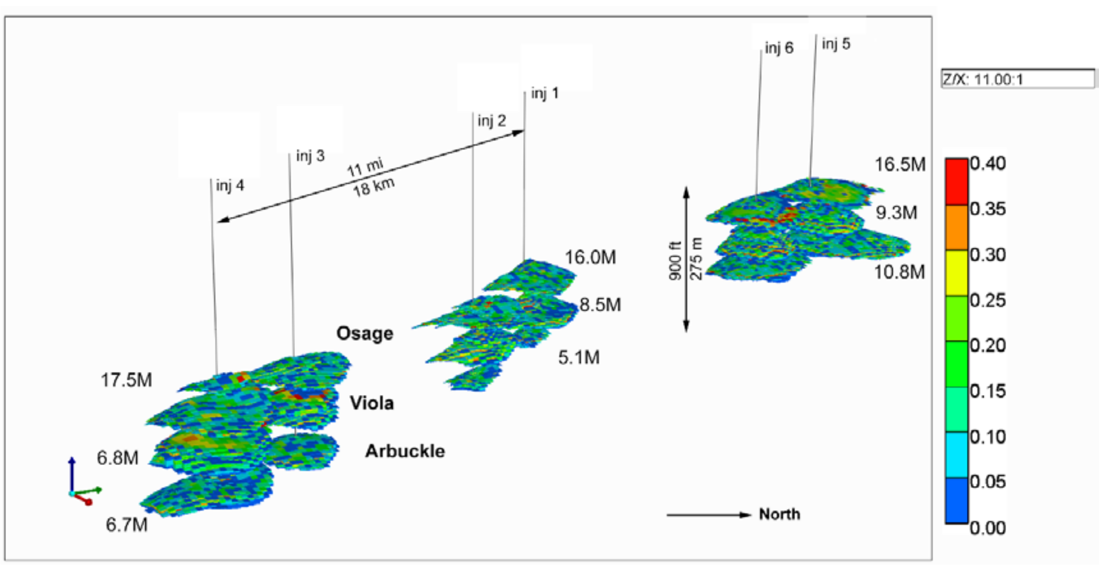


Figure 14. Dynamic simulation results showing CO2 plumes after 30 years of injection in the Arbuckle, Viola, and Osage. Numbers are CO2 volume stored for each plume (million tonnes).

Goals and objectives for the next Quarter:

- Complete a summary technical report for the Rupp geological site.
- Complete high-level technical evaluation reports for the Patterson, Lakin, Rupp, and Pleasant Prairie sites.
- Complete technical risk assessments for the Patterson site.
- Complete initial draft of final technical report

Products for Subtask 4.2:

- Summary technical report for the Pleasant prairie site (capacity, injectivity, seals) presented in the body of this report.
- Rupp site preliminary injection and storage capacity documented through simulations.

Subtask 4.3 - Compare results using NRAP with methods used in prior DOE contracts including regional and sub-basin CO_2 storage

Significant accomplishments: Nothing to report.

References:

Bui, L. H., Tsau, J. S., and Willhite, G. P., 2010, Laboratory investigations of CO2 near-miscible application in Arbuckle Reservoir: SPE Improved Oil Recovery Symposium held in Tulsa, Oklahoma, 24–28 April 2010, SPE Publication 129710.

Carter, R. D., and Tracy, G. W., 1960, An improved method for calculating water influx: Petroleum Transactions, AIME, vol. 219, p. 415–417.

Chang, K. W., Minkoff, S. E., and Bryant, S. L., 2009, Simplified model for CO2 leakage and its attenuation due to geological structures: Energy Procedia, v. 1, p. 3,453–3460.

Dake, L. P., 1978, Fundamentals of Reservoir Engineering," Chapter 9, Elsevier Scientific Publishing Co., 1978.

Doveton, J.H., 2004, Applications of estimated formation water resistivities to brine stratigraphy in the Kansas subsurface: Kansas Geological Survey, Open-File report 2004-22, 20 p.

Watney, W.L. et al., 2015, Modeling CO2 Sequestration in Saline Aquifer and Depleted Oil Reservoir to Evaluate Regional CO2 Sequestration Potential of Ozark Plateau Aquifer System, South-Central Kansas, Final Report, Award Number: DE-FE0002056, submitted October 2, 2015, 4867 p.

Watney, W.L., 2016, Integrated CCS for Kansas (ICKan) SF 424 R&R, Application for Federal Assistance, Phase I - Integrated CCS Pre-Feasibility Study activity under CarbonSAFE, DOE-NETL FOA 1584.

Task 5.0 – Perform a high level technical CO2 source assessment for capture

An assessment of the capture technologies best suited for efficiency, addressing the concerns of the electric utilities and their operating requirements and economic needs will be performed.

Subtask 5.1- Review current technologies and CO_2 sources of team members and nearby sources using NATCARB, Global CO_2 Storage Portal, and KDM

The CCS team shall develop an organized electronic clearinghouse of vital information pertaining to the project, ranked by suitability, historical usage records, adaptability, scaling, and demonstration of success, and operations and maintenance requirements.

Summary of Activities: Completed in Q1

Significant Results/Key Outcomes: Completed in Q1

Subtask 5.2- Determine novel technologies or approaches for CO_2 capture

Goals and Objectives: CO_2 sources shall carefully be evaluated for suitability with new capture technologies. The evaluation will utilize private research including that sponsored by DOE and results of international efforts and projects such as DOE's Carbon Capture Simulation Initiative (CCSI) to determine the suitability and rational for making decisions to pursue or table the technology.

Summary of Activities: Completed in Q2.

Significant Results/Key Outcomes: Completed in Q2.

Subtask 5.3- Develop an implementation plan and strategy for cost effective and reliable carbon capture

Goals and Objectives: An optimal CCS plan and strategy that best represents the holistic operating environment and requirements of the CO_2 sources will be developed. The team shall develop a means to ensure a mechanism to update and adapt to new disruptive technologies and possibly accommodate them in the design document.

Summary of Activities: Completed in Q2

Significant Results/Key Outcomes: Completed in Q2

Goals and objectives for the next Quarter:
During the next two quarters, the team will consolidate data and preliminary reports into a comprehensive final report.

Products for Subtask 5: None to report.

Task 6.0 – Perform a high level technical assessment for CO2 transportation

Subtask 6.1 - Review current technologies for CO_2 transportation

Nothing to report. Work is essentially complete.

Subtask 6.2- Determine novel technologies or approaches for CO_2 transportation

Nothing to report. Work is essentially complete.

Subtask 6.3 - Develop a plan for cost-efficient and secure transportation infrastructure

Overview:
Understanding the economics of transporting CO2 from anthropogenic sources in the most optimal manner is a key component of the ICKan project. In December, 2017, three Phase I pre-feasibility projects agreed to combine efforts for a single, Phase II proposal with Battelle as the lead. The combined project involves the ICKan Project (KGS, FE0029474), and two others, Nebraska Integrated Carbon Capture and Storage Pre-Feasibility Study (Energy and Environmental Research Center, **FE0029186**), and the Midcontinent Stacked Carbon Storage Hub Project (Battelle, **FE0029264**). In the current quarter, several possible source-geologic site scenarios for the combined Phase II project were evaluated.

Summary of significant activities:

Nothing to report. Work is essentially complete.

Significant Results/Key Outcomes:

Nothing to report. Work is essentially complete.

Products for Subtask 6.3:

None to report. Work is essentially complete.

Goals and objectives for the next Quarter:

During the next quarter, the team will consolidate data and preliminary reports into a comprehensive final report.

Task 7.0 – Technology Transfer

Efforts began to develop a CO_2 –ready catalog for potential CO_2 –EOR sites. A search area was created to search for wells and the available data in the Kansas Geological Survey Database. All available field information was provided to the team to begin developing an inventory and refining the dataset. The project web page provided direct access to the wells in the study areas. The web page URL is http://www.kgs.ku.edu/PRS/ICKan/Summary/.

Subtask 7.1- Maintain website on KGS server to facilitate effective and efficient interaction of the team

The ICKan Project Well Data Summary Web Page provides a publicly available database for users to view and download data collected from the ICKan project. This paged is updated on a regular basis and maintained by KGS staff.

Subtask 7.2 - Public presentations

Presentations were given at the annual Stanford Carbon Capture and Storage workshop in Palo Alto, CA and AAPG in Salt Lake City, UT in May.

Updates posted to the ICKan project page (http://www.kgs.ku.edu/PRS/ICKan/presentations.html).

Subtask 7.3 - Publications

Publications are posted to the ICKan project page.