Energy & Environmental Research Center
15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

April 27, 2022

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Quarterly Status Report for the Period of January 1 – March 31, 2022, "Field Study to Determine the Feasibility of Developing Salt Caverns for Hydrocarbon Storage in Western North Dakota"; Contract No. G-054-104

Attached please find the Energy & Environmental Research Center (EERC) Quarterly Status Report for the subject project. If you have any questions, please contact me by phone at (701) 777-5181 or by e-mail at ssmith@undeerc.org.

Sincerely,

DocuSigned by:
Steve Smith
92138D2CF98E498...

Steven A. Smith
Assistant Director, Integrated Analytical Solutions

SAS/rlo

Attachment

c/att: Brent Brannan, North Dakota Industrial Commission

FIELD STUDY TO DETERMINE THE FEASIBILITY OF DEVELOPING SALT CAVERNS FOR HYDROCARBON STORAGE IN WESTERN NORTH DAKOTA

Quarterly Project Status Report

(for the period January 1 – March 31, 2022)

Prepared for:

Karlene Fine

North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Contract No. G-054-104

Prepared by:

Steven A. Smith
Arash Abarghani
Matthew L. Belobraydic
Carrie C. Christianson
Stacy J. Kouba
John S. Oleksik

Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

April 2022

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FIELD STUDY TO DETERMINE THE FEASIBILITY OF DEVELOPING SALT CAVERNS FOR HYDROCARBON STORAGE IN WESTERN NORTH DAKOTA

EXECUTIVE SUMMARY

The Energy & Environmental Research Center (EERC) was awarded a contract by the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP), NDIC No. G-054-104, to conduct a study on the feasibility of developing salt caverns in geologic formations in North Dakota for underground storage of energy resources, including natural gas, liquified natural gas, and hydrogen, as directed by Section 14 of North Dakota Senate Bill 2014. The EERC, in partnership with Bakken Energy, Neset Consulting Services (Neset), and the University of North Dakota (UND) Department of Petroleum Engineering, will validate the suitability of salt formations for cavern development and provide stakeholders with information needed to assess the techno-economic viability of storing hydrocarbons and/or hydrogen in engineered salt caverns in North Dakota. This update is for January 1 through March 31, 2022.

This quarter, recurring meetings began with the industry advisory board (IAB). Currently ATCO, Bakken Energy, Catahoula Resources, Lane Power and Energy Solutions, Lonquist, Mitsubishi Power, Neset, ONEOK, Pivotal Energy, Texas Brine Company, and WSP have representatives on the board. A kickoff meeting was held, and additional meetings occurred to incorporate IAB expertise into the site selection, drilling and coring operations, and engineering analysis.

After performing a screening study to identify promising locations in western North Dakota for amenable salt formations and incorporating additional site selection criteria, including topography and proximity to roads, surface water, and disposal wells, a site was selected for drilling the stratigraphic test well. The preexisting well pad for an abandoned well will be used. This approach will expedite the drilling of the test well and save in pad development and road work costs.

In preparation for the drilling and core collection, targeted to begin in late May 2022, the subcontract with Neset was executed, and drilling, coring, and logging plans were developed. Work also began on securing surface use agreements and the drilling permit.

FIELD STUDY TO DETERMINE THE FEASIBILITY OF DEVELOPING SALT CAVERNS FOR HYDROCARBON STORAGE IN WESTERN NORTH DAKOTA

INTRODUCTION

The Energy & Environmental Research Center (EERC) was awarded a contract by the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP), NDIC No. G-054-104, to conduct a study of the feasibility of developing salt caverns in geologic formations in North Dakota for underground storage of energy resources, including natural gas, liquified natural gas, and hydrogen, as directed by Section 14 of North Dakota Senate Bill 2014. The EERC, in partnership with Bakken Energy, Neset Consulting Services (Neset), and the University of North Dakota (UND) Department of Petroleum Engineering, will validate the suitability of salt formations for cavern development and provide stakeholders with information needed to assess the techno-economic viability of storing hydrocarbons and hydrogen in engineered salt caverns in North Dakota.

This study follows a preliminary evaluation of the potential of salt cavern development completed by the EERC in December 2020. The 2020 study identified three salt formations deemed worthy of further investigation for characterization activities to inform future cavern development studies.

The goal of this field study is to validate the depth, thickness, and geologic and geomechanical suitability of the North Dakota salt formations for salt cavern development. The anticipated outcome is key information, needed by the state, the oil and gas industry, and other interested parties, to assess the techno-economic viability of storing hydrocarbon gases and hydrogen in engineered salt caverns.

This project will incorporate field, laboratory, modeling/simulation, and engineering analysis and design to determine the potential for salt cavern development in North Dakota. The work will be conducted in seven tasks.

ACCOMPLISHMENTS DURING REPORTING PERIOD

Project Management

This task includes the necessary activities to direct the project to meet all technical, schedule, and budget requirements. Work under this task will ensure that project plans, results, and decisions are appropriately documented and project reporting and briefing requirements are satisfied.

Significant accomplishments during the reporting period include the following:

- Regularly scheduled update meetings continued this quarter to discuss progress on the project.
- The Neset drilling and core collection subcontract was executed on January 11, 2022.
- The second quarterly report was submitted on January 27, 2022.
- A kickoff meeting was held with the industry advisory board (IAB) on February 4, 2022, to outline the effort, progress, and expectations of the IAB.
- The second meeting with the IAB was held on March 1, 2022, to get input on the site-screening study results, stratigraphic test well site selection criteria, and drilling and core collection plans.
- Representatives from ATCO, Bakken Energy, Catahoula Resources, Lane Power and Energy Solutions, Lonquist, Mitsubishi Power, Neset, ONEOK, Pivotal Energy, Texas Brine Company, and WSP currently participate on the IAB.
- Discussions have taken place to potentially bring RESPEC onto the project to advise on core collection and conduct testing on the recovered salt core.

Site Screening and Characterization

In this task, potential locations with amenable salt formations will be identified and targeted for screening and characterization. Screening criteria will be based on the interpretation of publicly available wireline logs, thickness, confinement, and depth. Several potential site locations will be identified, and some small-scale, localized geologic modeling will be performed to inform decision making.

Significant accomplishments during this reporting period include the following:

- This task is complete.

Site Selection/Land Permitting

In this task, the potential project locations identified in the Site Screening and Characterization task will be evaluated with project partners. Surface and subsurface rights will be secured. Permits will be secured in preparation for drilling.

Significant accomplishments during this reporting period include the following:

- An interactive ArcGIS map application was developed. Results from the site-screening study, topography, and nearby wells were included to further refine the potential areas for drilling the stratigraphic test well.

- Location options for the stratigraphic test well were chosen, completing Milestone M5.

- In the proposed plan, Bakken Energy agreed to secure the land options and surface and subsurface rights for drilling the stratigraphic test well; however, as the evaluation progressed, the opportunity of using an abandoned well pad, already confiscated by the state for plugging and abandoning, became an option for placing the stratigraphic test well. The preexisting pad for Well 15879 was chosen. Using the existing well pad will expedite the process and save in pad development and roadwork costs.

- Neset began working with NDIC and legal counsel on the surface use agreements.

- The process of preparing a drilling permit began.

Drilling and Core Collection

As part of this task, a stratigraphic test well will be drilled at the selected site. The well will be logged, and core will be collected through the target salt formations. Neset will provide general contracting services and will work closely with the EERC throughout the process from planning to site closure.

Significant accomplishments during this reporting period include the following:

- The drilling and coring plan was finalized with input from the IAB and modeling team.

- An initial logging plan was developed that incorporated input from the IAB. The logging plan will be finalized with input from the modeling team.

- EERC and Neset team members met on March 28, 2022, to discuss well planning and developed a list of action items that need to be addressed prior to submitting the application for permit to drill.

- The current estimated spud date for the stratigraphic test well is May 23, 2022.

Core Testing and Interpretation

This task includes all the core testing and interpretation. Tests will be performed to identify bulk characteristics of the formation, including lithology, thickness, porosity, permeability, mineralogy, geomechanical competency of the overlying and underlying sealing formations, geomechanical properties of the salts, and dissolution properties of the salts.

Significant accomplishments during this reporting period include the following:

- No progress to report during this reporting period.

Geologic and Geomechanical Modeling

As part of this task, modeling will be performed based on site-specific data generated through the drilling and core testing. Geologic models will be developed to inform the subsurface geologic regime and evaluate the regional structural and stratigraphic trends. Geomechanical modeling will incorporate information derived from the geologic models, and the site-specific data and will inform the overall cavern dimensions and operational stability.

Significant accomplishments during this reporting period include the following:

- The modeling team provided input for the site selection and stratigraphic test well-coring plans.

- The modeling team met to plan the model-building effort. After the site was selected, the team began its search for available data sets nearby. This effort will continue next quarter.

Engineering Analysis and Design

This task includes the detailed engineering design and analysis that will be performed to identify surface equipment needs; design specifications; brine handling, use, and disposal practices; and monitoring needs. The EERC will also seek advisement from external engineering teams with expertise in developing and operating salt caverns used for hydrocarbon storage. Site-specific implementation plans for future cavern development will be created.

Significant accomplishments during this reporting period include the following:

- The project team and a subset of the IAB – ATCO, Lonquist, Lane, ONEOK, and Texas Brine Company – met to discuss salt cavern facility engineering.

- An initial engineering analysis was performed, completing Milestone M4. Analysis included investigation of stored fluids, capacities, facility equipment, supporting infrastructure, operation, injection/withdrawal cycle, and maintenance.

- Salt cavern facilities include the leaching facility for development, a gas-driven storage system, and a brine-driven storage system. These types of facilities vary from each other but within a category are similar. Rather than starting with nothing, purchasing a generic design and iterating with North Dakota-specific parameters will streamline the process.

FINANCIAL INFORMATION

This study is sponsored by NDIC OGRP. Table 1 presents the expected budget and expenses to date for the study.

Table 1. Salt Cavern Study – Expected Budget and Expenses to Date

Sponsors	Expected Budget	Actual Expenses as of 3/31/2022	Balance
NDIC Share – Cash	$9,500,000	$395,285	$9,104,715
Bakken Energy – In-Kind*	$500,000	$0	$500,000
Total	**$10,000,000**	**$395,285**	**$9,604,715**

* The Bakken Energy in-kind cost share was for securing land options and surface and subsurface rights for drilling the stratigraphic test well. By using a preexisting well pad for siting the stratigraphic test well, this need no longer exists. A contract modification is in progress.

PLANNED FUTURE ACTIVITIES

The following activities are planned for the next quarter.

Project Management

- Bring RESPEC onto the project.
- Hold the third meeting of the IAB.
- Several members of the project team will attend the Solution Mining Research Institute's (SMRI's) spring conference either virtually or in person.
- Continue regularly scheduled update meetings.

Site Screening and Characterization

- This task is complete.

Site Selection/Land Permitting

- Secure the drilling permit.
- Secure the surface use agreements.

Drilling and Core Collection

- Finalize the logging plan.
- Complete the site preparation.
- Complete the drilling and core collection operations (Milestone M7).

Core Testing and Interpretation

- Initiate the core-testing effort.

Geologic and Geomechanical Modeling

- Complete the data review and audit of all wells around the site to support geology, petrophysics, geomechanics, and geomodeling workflows.
- Initiate the geologic and geomechanical site-specific models (Milestone M6).
- Build initial interpretations from legacy data to support the drilling of the stratigraphic test well.
- Develop a petrophysical model to characterize all salts, interbeds, and surrounding formations within the area of interest.
- Correlate wells within the area of interest to characterize structure and stratigraphy of salts, interbeds, and surrounding formations.
- Identify and start digitizing any legacy core or well log data to fill gaps within the area of interest.

Engineering Analysis and Design

- Purchase generic conceptual designs for salt cavern facilities.
- Begin development of models from purchased conceptual designs. Models will serve as a basis for site-, geological-, and state-specific inputs identified throughout later quarters of project.
- Perform a preliminary costing investigation of facility components through contact with vendors, modeling, and literature reviews to inform the final design.