EERC
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

November 1, 2024

Mr. Reice Haase
Deputy Executive Director
ATTN: Oil and Gas Research Program
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: EERC Proposal No. 2025-0053 Entitled "Injection Testing with Propane to Inform Future Bakken $CO_2$ EOR Pilot" in Response to the North Dakota Industrial Commission Oil and Gas Research Program Solicitation

The Energy & Environmental Research Center (EERC) at the University of North Dakota is pleased to submit the subject proposal to the Oil and Gas Research Program. The $100 application fee is provided through ACH transaction number 281611. The EERC is committed to completing the project as described in the proposal if the Commission makes the requested grant.

If you have any questions, please contact me by telephone at (701) 777-5287 or by email at jsorensen@undeerc.org.

Sincerely,

DocuSigned by:
Jim Sorensen
0671D00C8437443...

James A. Sorensen
Director of Subsurface Research and Development

Approved by:

DocuSigned by:
Tami Votava
E7468BBB3DE440E...
*for*

Charles D. Gorecki, CEO
Energy & Environmental Research Center

JAS/rlo

Attachment

c: Erin Stieg, North Dakota Industrial Commission

# Oil and Gas Research Program

North Dakota

Industrial Commission

## Application

**Project Title:** Injection Testing with Propane to Inform Future Bakken $CO_2$ EOR Pilot

**Applicant:** University of North Dakota Energy & Environmental Research Center

**Principal Investigator:** James A. Sorensen

**Date of Application:** November 1, 2024

**Amount of Request:** $1,800,000

**Total Amount of Proposed Project:** $4,000,000

**Duration of Project:** 12 months

**Point of Contact (POC):** James A. Sorensen

**POC Telephone:** (701) 777-5287

**POC E-Mail Address:** jsoresen@undeerc.org

**POC Address:** 15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

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## ABSTRACT

**Objective:** The Energy and Environmental Research Center (EERC) proposes to investigate the response of a Bakken reservoir to injecting propane or another readily available natural gas liquid (NGL) as a means of informing the design and operation of a future larger-scale $CO_2$ enhanced oil recovery (EOR) pilot test in the Bakken. This will be accomplished by completing a suite of activities, which include laboratory-based propane-rock interaction, propane-oil phase behavior and miscibility investigations, an injection test into a Bakken well, reservoir surveillance efforts to determine injectivity and reservoir response, and modeling-based activities to determine optimal injection scheme and operational strategies for the future $CO_2$ EOR pilot.

**Expected Results:** Specific data that will be developed by a propane injection test include bottomhole reservoir pressure data, injectivity data, pressure buildup and dissipation rates, evidence of communication with offset wells (i.e., injection conformance within the target reservoir), and fluid flowback rates (oil, gas, water, injectate). Aspects of the larger-scale $CO_2$ EOR pilot design that will be informed by the propane injection test include the sizing and design of compression, sizing and design of flowback management systems, and design of a cost-effective reservoir surveillance system.

**Duration:** The period of performance for the proposed project is 12 months.

**Total Project Cost:** A cash contribution of $1,800,000 from the North Dakota Industrial Commission Oil and Gas Research Program would be used to support EERC laboratory, modeling, and project management activities, and Chord Energy activities to execute the propane injection test. In-kind contributions estimated to be valued at a minimum of $2,200,000 would be provided by Chord Energy to implement and operate the propane injection test in the field. The in-kind contribution from Chord Energy would include, but not necessarily be limited to, the acquisition, delivery, and injection of propane or other readily available NGL into a selected Bakken well.

**Participants:** The EERC and Chord Energy.

## PROJECT DESCRIPTION

In September 2024, the U.S. Department of Energy (DOE) formally awarded a contract to the Energy & Environmental Research Center (EERC) to establish the Bakken $CO_2$ Enhanced Oil Recovery and Storage Field Laboratory (Bakken $CO_2$ EORSFL). Chord Energy has committed to being the operating partner with the EERC on the Bakken $CO_2$ EORSFL, serving as the host and operator for a future $CO_2$ enhanced oil recovery (EOR) pilot test in one of its Bakken drill spacing units (DSUs) in the Grail Field in McKenzie County, North Dakota. The current timeline for the Bakken $CO_2$ EORSFL project calls to begin injecting $CO_2$ for the EOR pilot in late 2026 or early 2027. The EERC's experience with EOR pilots in the Bakken indicates that early injection tests can provide invaluable injectivity and reservoir response data that streamline and optimize design and planning for the larger pilot operations. Such pre-pilot injection tests do not necessarily need to use the same working fluid as the main pilot test if the reservoir behavior relationships (e.g., miscibility, swelling) between the pre-pilot working fluid and main pilot working fluid are well understood. To facilitate and accelerate the design and planning of the $CO_2$ EOR pilot for the Bakken $CO_2$ EORSFL, the EERC proposes partnering with Chord Energy to conduct a pre-pilot injectivity test using propane. The hypotheses for the proposed efforts build on several key factors:

1. **Small-scale injection tests inform design and operations of future large-scale injection tests:** Small-scale injection testing operations were a cost-effective means of developing valuable information for planning and operating three Bakken EOR pilots in which the EERC was involved (1–3). Key design factors informed by injection tests include reservoir pressure and temperature, injectivity, conformance of injectate within the target reservoir (i.e., connectivity with offset wells), pressure buildup rates during injection and decline rates after, compression design and sizing, and flowback management requirements.
2. **Availability:** The necessary volumes of propane and other natural gas liquids (NGLs) are readily available from multiple gas processing plants around Chord Energy's Bakken production. If

propane cannot be cost-effectively acquired, then other NGLs will be considered as an alternative working fluid.

3. **Phase behavior calibration and optimization:** Previous EERC laboratory and modeling studies have suggested $CO_2$ and other hydrocarbons (including propane) are working fluids with strongly similar reservoir behavior (4–6). These documented similarities allow for the results from tests using a hydrocarbon working fluid, such as propane, to be calibrated to predict the behavior and effects of $CO_2$ under the same reservoir conditions. This indicates that the results of an injection test that uses propane can be directly applied to predicting the results of an EOR operation that uses $CO_2$.
4. **Reduced formation damage:** Propane may help mitigate some of the issues associated with other working fluids used for injection tests (e.g., produced water, fresh water), such as formation damage or wettability alteration, maintaining the integrity of the reservoir for future $CO_2$ EOR operations.

**Methodology:** This project will consist of multiple tasks including project management and reporting, laboratory investigations, geologic modeling and reservoir simulation, and a field injection test.

***1.0 – Project Management and Reporting*:** In this task, EERC management will ensure all project activities stay within budget and on schedule and all project objectives are achieved. EERC management will ensure all technical activities are coordinated effectively between internal EERC laboratory and modeling teams and between EERC technical teams and the appropriate personnel at Chord.

***2.0 – Laboratory Investigation*:** In this task, Bakken rock and fluid samples from the Grail Field will be analyzed to determine how the targeted injection reservoir interacts with propane under reservoir conditions. The data generated will serve as necessary inputs for geologic modeling and reservoir simulation efforts.

*2.1– Evaluation of Rock and Fluid Properties:* Rock and fluid samples from the Grail Field will be evaluated to determine their physical properties. These evaluations aim to provide a detailed understanding of the properties of both rock and fluid samples, providing the fundamental data required to develop an accurate reservoir geomodel and serve as the basis for numerical simulations of both the preinjection predictive modeling and postinjection history matching exercises.

*2.2 – Evaluation of Rock–Fluid and Fluid–Fluid Interactions:* In this subtask, various rock–fluid and fluid–fluid interactions will be examined to provide insights into the behavior of propane and reservoir fluids in the Grail Field Bakken reservoir. The acquired data will provide input for reservoir simulation model calibration and tuning.

***3.0 – Reservoir Modeling, Simulation and Calibration*:** Reservoir modeling, simulation, and calibration will be performed throughout the project. A comprehensive reservoir simulation model including key geologic, reservoir, and operational elements will be developed to mimic the propane injection and associated reservoir response for the selected site.

*3.1 – Geologic Modeling and Reservoir Simulation:* A 3D geologic model will be constructed based on the geologic properties from well logs and/or existing core data from the pilot area. The target injection zones (the Bakken and Three Forks Formations) will be incorporated within the site geologic model. A compositional reservoir simulation model will be developed based on the geologic model and laboratory measurements of rock and fluid properties. A detailed history match of fluid production (oil, gas, water) will be conducted to tune the simulation model and make sure it can fully and accurately mimic the reservoir dynamics.

*3.2 – Propane Injection Simulation and Injection Test Design:* A simulation matrix will be designed to forecast the effectiveness of a propane injection test considering key operational variables. The simulation results will be used to design the operational parameters for the propane injection test. Advisement on the injection test design will be provided from an external reservoir engineering advisor,

Mr. Gordon Pospisil with Liberty Resources Advisors LLC, who has extensive experience using reservoir simulations to plan and execute injection tests in the Bakken and interpreting and analyzing their results (2–3).

*3.3 – Injection Test Data Analysis and Model Calibration:* A series of data monitoring, collection, and analysis activities will be performed to better understand the reservoir behavior and fully assess the response of the reservoir to the propane injection (Task 4.0). Key variables such as injection rate, wellhead and/or bottomhole injection pressure, offset well production responses, produced oil and gas composition, etc. will be closely monitored over the course of the injection test. The comprehensive dataset will be analyzed, processed and then used to calibrate the simulation model to ensure it can capture the reservoir dynamics in the Grail Field Bakken reservoir.

*3.4 – Propane- and $CO_2$-EOR Correlation and Calibration:* The similarities and differences between propane- and $CO_2$-EOR will be evaluated based on the laboratory measurements and propane injection test results from Tasks 2.0 and 4.0. This data will be used to correlate and calibrate the EOR processes of injecting propane and $CO_2$ under the same reservoir conditions. The insights from the propane injection test and the calibrated simulation model will facilitate and accelerate the design of an effective future large-scale $CO_2$ EOR pilot test.

***4.0 – Field Propane Injection Test and Reservoir Surveillance*:** A propane injection test into an existing hydraulically fractured horizontal Bakken well in the Grail Field (Figure 1) will be planned and conducted by Chord Energy, utilizing data and insights gained from Tasks 2.0 and 3.0. The volume of propane to be injected, the duration of injection, and the number of cycles of injection are critical operational parameters that will be directly informed by the reservoir modeling and simulation. Final DSU and well selection may be adjusted based on learnings from the reservoir simulation efforts but will ultimately be selected to ensure that the results directly apply to the later large-scale $CO_2$ EOR pilot test to be performed under the separate Bakken $CO_2$ EORSFL project.

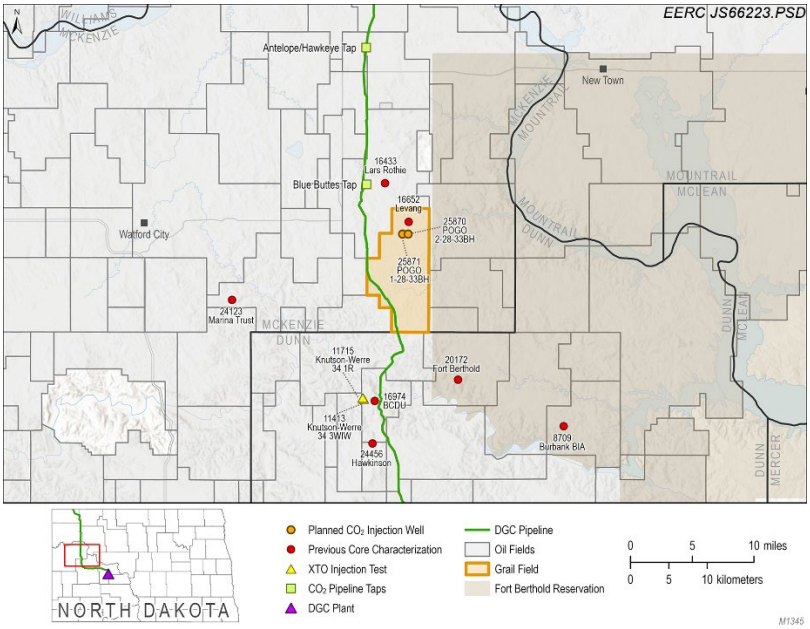



Figure 1. Map showing planned location of $CO_2$ EOR pilot in Grail Field, McKenzie County.

A reservoir surveillance system will be developed and implemented within the project area to determine injectivity and reservoir response. The ability to calibrate and ground truth the model with the data obtained from the propane injection test will facilitate and accelerate the design of the large-scale $CO_2$ EOR pilot test that is part of the Bakken $CO_2$ EORSFL.

**Anticipated Results:** A propane injection test into a Bakken reservoir will generate data that can provide invaluable insight regarding the detailed design and operation of the injection scheme for a future large-scale $CO_2$ EOR pilot. Specific data developed by the propane injection test that will be critical to planning the future $CO_2$ EOR pilot include bottomhole reservoir pressure data, injectivity data, pressure buildup and dissipation rates, evidence of communication with offset wells (i.e., injection conformance within the target reservoir), and fluid flowback rates (oil, gas, water, injectate). Aspects of the larger-scale $CO_2$ EOR pilot design that will be informed by the propane injection test include the sizing and design of compression, sizing and design of flowback management units, and design of an effective reservoir surveillance system. Laboratory evaluations of propane behavior in oil from the target Bakken reservoir and propane—oil—rock interactions using core samples from the area of the target reservoir can be

compared to the same evaluations that use $CO_2$ as the working fluid (to be conducted under the separate Bakken $CO_2$ EORSFL scope of work funded by the DOE). Modeling activities that incorporate the results of the propane injection test, when calibrated with data on $CO_2$ interactions with Bakken oil and rocks, will facilitate and accelerate the design of a large-scale $CO_2$ EOR pilot test anticipated to be performed in late 2026 or early 2027 under the Bakken $CO_2$ EORSFL.

**Facility, Resources, and Techniques to Be Used, Their Availability and Capability:** The EERC employs a multidisciplinary staff of about 300 and has 254,000 square feet of state-of-the-art offices, laboratories, and technology demonstration facilities, which enable staff to address a wide variety of research topics. The EERC houses eight analytical laboratories, including water resource characterization, petroleum resource characterization, and environmental chemistry. These laboratories have decades of experience and have been instrumental in previous Bakken research. The EERC has extensive Bakken-focused geologic modeling, reservoir simulation, and data analytics experience and capabilities, including high-end workstation computers and a dedicated high-performance parallel computing cluster.

**Environmental and Economic Impacts while Project is Underway:** Environmental impacts will be minimal during the execution of this project. Laboratory investigations, computer modeling and simulations, and ultimately a field injection test with associated reservoir surveillance will be conducted. Prior to the injection test, the necessary state regulatory approval process will be completed. Lab-scale evaluation of samples at the EERC will be in a controlled environment. The insignificant amount of materials used will be disposed of according to standard University of North Dakota (UND) environmental health and safety practices once the evaluations are complete. Economic impacts during the project will also be minimal and will not appreciably affect any of the organizations participating apart from regular employment economic effects for those working on the project.

**Ultimate Technological and Economic Impacts:** This project will offer new data, including laboratory- and field-validated insights regarding the detailed design and operation of the injection scheme for a

future large-scale $CO_2$ EOR pilot and serve as a basis for planning and procuring the proper associated infrastructure equipment and field services. This project combined with the larger $CO_2$ EOR pilot for the Bakken $CO_2$ EORSFL it is supporting could ultimately increase oil and gas industry operations in North Dakota by improving resource recovery, decreasing costs, reducing environmental impacts, and increasing revenue. Successful $CO_2$ EOR operations would extend the lifetime of the Bakken play by multiple decades and could yield billions of barrels of low-carbon-intensity incremental oil and natural gas, which would translate into billions of dollars of economic impact to North Dakota. Successful completion of the project will also demonstrate the technical viability and cost effectiveness of using propane and possibly other NGLs as a working fluid for injection tests and for EOR in its own right.

**Why the Project is Needed:** This project is needed to facilitate and accelerate the design and planning of the $CO_2$ EOR pilot for the Bakken $CO_2$ EORSFL. Its lessons will directly inform multiple aspects of the larger $CO_2$ EOR pilot scheduled to occur in late 2026 or early 2027. Successful $CO_2$ EOR pilot projects are crucial for unlocking the potential of this method of EOR in the Bakken petroleum system of North Dakota, and this project will directly provide data and insights that will enable the Bakken $CO_2$ EORSFL pilot to be designed cost-effectively, reducing the operational risk of the larger $CO_2$ EOR pilot and improving its chance of success. Ultimately, broad commercial deployment of $CO_2$ EOR has the potential to not only increase the North Dakota's oil production but also reduce the carbon intensity of the oil production through the storage of $CO_2$ underground that occurs during the process.

## STANDARDS OF SUCCESS

Success will be measured in this project's ability to generate key data and insights that will influence the design, planning, and execution of the $CO_2$ EOR pilot for the Bakken $CO_2$ EORSFL. These projects are steps on the path to unlocking the vast potential of $CO_2$ EOR in the Bakken petroleum system and to ensuring the continued success of the oil and gas industry in North Dakota. A strong oil and gas industry contributes to a robust state economy, which includes the creation and continuation of jobs that

support or are positively impacted by oil and gas development in the state. As a measure of success, biweekly meetings with the project partner, Chord Energy, will be held to discuss project status and results and to coordinate and plan project activities. The current North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP)-approved process of reporting will be employed to deliver results. High-level progress updates will be provided in semiannual reports to OGRP for inclusion on the OGRP website for immediate access by the public. A final report summarizing the project's outcomes will be prepared and delivered to OGRP at the end of the project.

## BACKGROUND/QUALIFICIATIONS

The EERC is a nonprofit branch of UND. Resumes of key personnel are provided in Appendix A. James Sorensen, Director of Subsurface Research and Development, will serve as Principal Investigator. Other key EERC personnel will include Bethany Kurz, Director Subsurface Characterization and Community Engagement; Steven Smith, Assistant Director for Integrated Analytical Solutions; Dr. Lu Jin, Distinguished Reservoir Engineer; Dr. Nidhal Badrouchi, Senior Research Scientist; and Michael Warmack, Distinguished Oil and Gas Facilities Engineer. Chord Energy, headquartered in Houston, Texas, is a publicly traded, independent energy company that acquires, develops, and explores for crude oil, natural gas, and NGLs in the Williston Basin. Ryan McGuigan, Managing Director of Engineering, will oversee Chord's involvement in this project, specifically all aspects of the field-based injection operations, including injection test site selection, acquisition and transportation of propane for the pre-pilot injection test, design and execution of the injection test, and operation and monitoring of any well(s) included in the injection test (including offset wells).

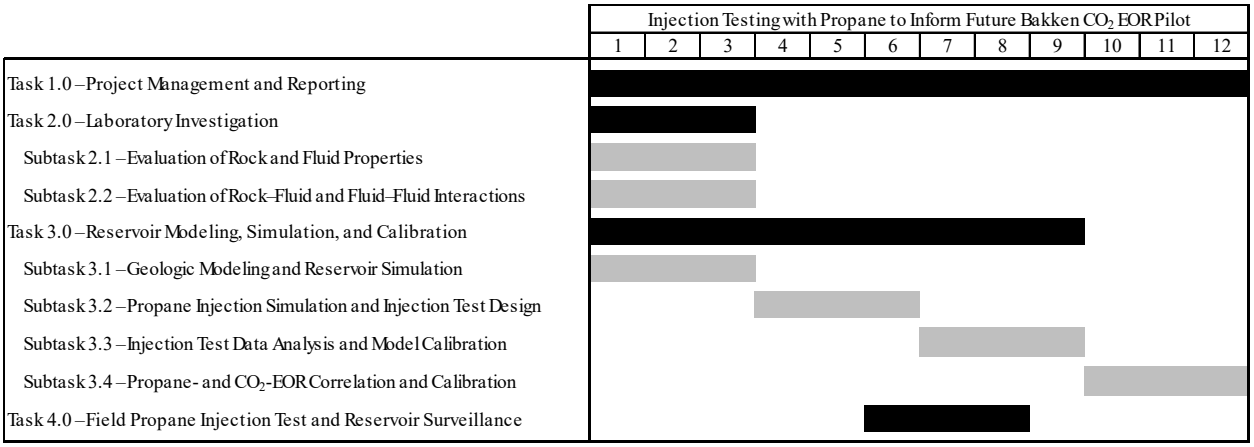
## MANAGEMENT

The EERC manages over 200 contracts a year, with a total of over 1300 clients in 53 countries. Systems are in place to ensure that projects are managed within budget, schedule, and scope. Mr. Sorensen will oversee the project, with assistance in management of project tasks by Ms. Kurz, Mr. Smith, Dr. Lu., Dr.

Badrouchi, and Mr. Warmack. This will involve integration of tasks, project reporting, and collaboration with our project partner, Chord Energy.

## TIMETABLE

The proposed project duration is 12 months (January 1, 2025 – December 31, 2025). The preliminary project timetable is summarized below.




ACR 11/1/24

## BUDGET

The total estimated cost for the proposed effort is $4,000,000. $1,800,000 is requested from OGRP. Chord has estimated that the anticipated cost to conduct the propane injection activities in the field is approximately $3,000,000. Estimated costs for the field-based activities include, but are not necessarily limited to, purchase of propane, propane transportation costs, pumping costs, downhole work, and surface work to support the execution of the injection test. This proposal requests that $800,000 of NDIC OGRP funding goes toward paying for costs incurred by Chord over the course of site preparation and injection test operations, with Chord anticipating to pay for field-based costs of approximately $2,200,000 to be shown as in-kind cost share to the project. The remaining $1,000,000 of NDIC OGRP funding would go toward EERC expenses for laboratory evaluations, modeling, injection test design and interpretation support, and project management. A letter of interest from Chord Energy can be found in Appendix B. Budget notes can be found in Appendix C.

| Project-Associated Expense | NDIC Share (cash) | Industry Share (in-kind) | Total Project |
|---|---|---|---|
| **Labor** | $565,103 | $0 | $565,103 |
| **Travel** | $3,258 | $0 | $3,258 |
| **Supplies** | $2,000 | $0 | $2,000 |
| **Subcontractor – Chord Energy** | $800,000 | $0 | $800,000 |
| **Consultant – Gordon Pospisil** | $9,000 | $0 | $9,000 |
| **Printing and Duplicating** | $135 | | $135 |
| **Laboratory Fees and Services** | | | |
| EERC Natural Materials Analytical Research Lab | $4,378 | $0 | $4,378 |
| EERC Gas chromatography–mass spectrometry Lab | $54,590 | $0 | $54,590 |
| EERC Document Production Service | $4,161 | $0 | $4,161 |
| EERC Technical Software | $2,122 | $0 | $2,122 |
| EERC Field Safety | $3,080 | $0 | $3,080 |
| EERC Geoscience Services | $5,980 | $0 | $5,980 |
| **Total Direct Cost** | $1,453,807 | $0 | $1,453,807 |
| **Facilities and Administration** | $346,193 | $0 | $346,193 |
| **Total Cash Requested** | $1,800,000 | $0 | $1,800,000 |
| **In-Kind Cost Share** | | | |
| Chord Energy | $0 | $2,200,000 | $2,200,000 |
| **Total In-Kind Cost Share** | $0 | $2,200,000 | $2,200,000 |
| **Total Project Cost** | $1,800,000 | $2,200,000 | $4,000,000 |

## TAX LIABILITY

The EERC, a department within UND, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability.

## CONFIDENTIAL INFORMATION AND PATENTS/RIGHTS TO TECHNICAL DATA

This proposal has no confidential information. No patentable technologies are expected to be created.

## STATUS OF ONGOING PROJECTS

The EERC is currently engaged in five OGRP-funded projects. These ongoing projects, listed in Appendix D, are current on all deliverables.

**References:**

1. Sorensen, J.A., Pekot, L.J., Torres, J.A., Jin, L., Hawthorne, S.B., Smith, S.A., Jacobson, L.L., and Doll, T.E., 2018, Field test of $CO_2$ injection in a vertical Middle Bakken well to evaluate the potential for

enhanced oil recovery and $CO_2$ storage: Paper presented at the Unconventional Resources Technology Conference, Houston, Texas, July 23–25, 2018, URTeC Paper No. 2902813.

2. Pospisil, G., Griffin, L., Souther, T., Strickland, S., McChesney, J., Pearson, C.M., Dalkhaa, C., Sorensen, J.A., Hamling, J.A., Kurz, B.A., Bosshart, N.W., Warmack, M.P., Assady, A., Zhao, J., Schwanitz, B., Williams, A., Schechter, D., and Sarmah, A., 2022, East Nesson Bakken enhanced oil recovery pilot—coinjection of produced gas and a water–surfactant mixture: Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Houston, Texas, June 20–22, 2022, Paper No. URTEC-3722974-MS. DOI: /10.15530/urtec-2022-3722974.
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4. Hawthorne, S.B., Pekot, L.J., Miller, D.J., Grabanski, C.B., Azzolina, N.A., Kurz, B.A., and Sorensen, J.A., 2023, Measured sorption isotherms for Bakken petroleum system shales using carbon dioxide and produced gas hydrocarbons at 110°C and pressures up to 34.5 MPa: Energy & Fuels, v. 37, p. 10970–10979. DOI: /10.1021/acs.energyfuels.3c01661.
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6. Zhao, J., Jin, L., Azzolina, N.A., Wan, X., Yu, X., Sorensen, J.A., Kurz, B.A., Bosshart, N.W., Smith, S.A., Wu, C., Vrtis, J.L., Gorecki, C.D., and Ling, K., 2022, Investigating enhanced oil recovery in unconventional reservoirs based on field case review, laboratory and simulation studies: Energy & Fuels, v. 36, p. 14771–14788. DOI: /10.1021/acs.energyfuels.2c03056.

# APPENDIX A

# RESUMES OF KEY PERSONNEL

**JAMES A. SORENSEN**
Director of Subsurface Research and Development
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5287, jsorensen@undeerc.org

***Education and Training***

M.Eng., Petroleum Engineering, University of North Dakota, 2020.
B.S., Geology, University of North Dakota, 1991.

***Research and Professional Experience***

**October 2019–Present:** Director of Subsurface Research and Development, EERC, UND.
Responsible for developing and managing programs and projects focused on conventional, unconventional, and enhanced oil and gas production; the geological storage of $CO_2$; and other energy and environmental research.
Primary areas of interest and expertise are enhanced oil recovery (EOR) in unconventional tight oil formations, $CO_2$ utilization and storage in geologic formations, and tight oil resource assessment and development.

**July 2018–September 2019:** Assistant Director for Subsurface Strategies, EERC, UND.
Developed business opportunities, provided technical support and guidance regarding emerging areas of research, and served as a principal investigator (PI) and task manager for projects related to the sequestration of $CO_2$ in geologic media and the sustainable development of tight oil resources.

**1999–July 2018:** Principal Geologist, EERC, UND.
Served as manager and co-PI for programs to develop strategies for $CO_2$ utilization and storage.
Led research focused on EOR in the Bakken.

**1997–1999:** Program Manager, EERC, UND.
Managed projects focused on produced water management and environmental fate of natural gas-processing chemicals.

**1993–1997:** Geologist, EERC, UND.
Conducted field-based hydrogeologic investigations focused on natural gas production sites.

**1991–1993:** Research Specialist, EERC, UND.
Assembled and maintained comprehensive databases related to oil and gas drilling, production, and waste management.

***Professional Activities***

Member, Society of Petroleum Engineers

***Publications***

Has coauthored nearly 200 publications.

**BETHANY A. KURZ**
Director of Subsurface Characterization and Community Engagement
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5050, bkurz@undeerc.org

***Education and Training***

M.S., Hydrogeology, University of North Dakota, 1998.
B.S., Geochemistry, Bridgewater State University, 1995.

***Research and Professional Experience***

**February 2024–Present:** Director of Subsurface Characterization and Community Engagement, EERC, UND.

- Leads programs, projects, and a multidisciplinary team of scientists and engineers in topics related to carbon capture, utilization, and storage (CCUS).
- Application of machine learning and artificial intelligence to CCUS and oil and gas development.
- Enhanced oil recovery (EOR).
- Produced water and drilling waste management.
- Critical materials resource assessments.
- Development and implementation of community benefits plans, societal impact assessments, stakeholder engagement, and public outreach.

**May 2021–February 2024:** Director of Analytical Solutions, EERC, UND.

- Developed business and research opportunities to address challenges in all areas of energy and natural resources development and management.
- Led programs and projects related to CCUS; application of machine learning and artificial intelligence to CCUS and conventional and unconventional oil and gas development; EOR; produced water and drilling waste management; and critical materials resource assessments.
- Led EERC research laboratories and a multidisciplinary team of scientists and engineers focused on addressing the needs of our partners and clients in areas related to energy development and management and environmental stewardship.

Principal areas of interest and technical expertise include CCUS; produced natural gas storage; EOR in conventional and unconventional oil and gas reservoirs; application of machine learning and data analytics to CCUS and oil and gas development; produced water and drilling waste management; assessment of critical materials in coal and produced brine; and resource management related to energy development.

**July 2018–April 2021:** Assistant Director of Integrated Analytical Solutions, EERC, UND.

- Assisted EERC leadership with developing business opportunities and successfully executing research projects related to oil and gas; natural resource management; and CCUS.
- Oversaw a multidisciplinary team of scientists and engineers who work in EERC applied research laboratories, ensuring the quality assurance/quality control of data and results generated by EERC

laboratories and integrating those results into the applied research efforts conducted by the Subsurface R&D team.

**2011–July 2018:** Principal Hydrogeologist, Laboratory Analysis Group Lead, EERC, UND.

- Oversaw a multidisciplinary team of scientists and engineers and several EERC analytical research laboratories that focus on classical and advanced wet-chemistry analyses; petrochemical, geochemical and geomechanical evaluation of rocks and soils; and advanced characterization of various materials, including metals, alloys, catalysts, and corrosion and scale products.

Primary areas of interest included the evaluation of water supply sources for the oil and gas industry, produced water management, characterization of geologic media for carbon storage, and development and testing of proppants for use in hydraulic fracturing.

**2002–2011:** Senior Research Manager, Water Management and Flood Mitigation Strategies, EERC, UND.

- Responsibilities included project management, technical report and proposal writing, public outreach, and the development of new research focus areas.
- Research activities included evaluation of nontraditional water supply sources for municipal and industrial use, flood and drought mitigation, watershed-scale water quality assessments using hydrologic models, and public education and outreach on various water and energy issues.

**1998–2002:** Research Scientist, Subsurface Remediation Research, EERC, UND.

- Responsibilities included managing and conducting research involving remediation technologies for contaminated groundwater and soils, groundwater sampling and analysis, technical report writing, and proposal research and preparation.

***Publications***

Has coauthored numerous professional publications.

**STEVEN A. SMITH**
Assistant Director, Integrated Analytical Solutions
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5108, ssmith@undeerc.org

***Education and Training***
B.S., Geology, University of North Dakota, 2001.

***Research and Professional Experience***
**2018–Present:** Assistant Director, Integrated Analytical Solutions, EERC, UND.

- Develops new business opportunities related to laboratory- and field-based investigations of enhanced oil recovery (EOR), $CO_2$ storage, and resource assessment of unconventional oil plays.
- Focuses on research opportunities and methods development for core-scale rock characterization, fluid behavior, and organic petrology.

Principal areas of interest and expertise are petroleum geology, $CO_2$ EOR, laboratory investigation of fluid flow in conventional and unconventional reservoirs, and geological sequestration of $CO_2$.

**2010–2018:** Senior Geologist, AGL Team Lead, EERC, UND.

- Worked with multidisciplinary team collaborating on research activities devoted to furthering understanding of subsurface geological environment.
- Managed Applied Geology Laboratory (AGL), which actively pursues research into derivation of physical properties of rocks and encompasses disciplines of petrophysics, geochemistry, and geomechanics. The primary focus of the AGL is oil and gas industry and carbon capture and storage marketplace.

**2004–2010:** Research Scientist, EERC, UND.

- Developed and implemented work plan for acid gas monitoring, verification, and accounting (MVA) for Zama acid gas disposal and EOR project in Alberta.
- Coordinated engineering, geological, geomechanical, and geochemical characterization activities for Zama project.
- Developed and maintained database of oil-bearing geologic reservoir characteristics as they pertain to $CO_2$ storage in states and provinces of Plains $CO_2$ Reduction (PCOR) Partnership region.
- Evaluated saline aquifer systems and determined potential for $CO_2$ sequestration.
- Developed estimates of $CO_2$ storage capacity within oil-bearing and saline strata of Williston, Alberta, Powder River, and Denver–Julesburg Basins.
- Worked as wellsite geologist in Williston Basin.

**2001–2003:** Wellsite Geologist, Subcontractor, Baker, Montana.

- Oversaw all of oil company's interests with respect to geologic decisions on location.
- Prepared morning report and geologic strip logs to summarize well progression.
- Directed interaction with oil company upper management.
- Evaluated sample cuttings, gas, and drill times while project well was drilling.

- Performed structural geologic correlation with offset wells.
- Worked in close communication with directional driller and rig crew to maintain accuracy in completion of well.

**1994:** Staff Geologist Intern, R.E. Wight Associates, Inc., Middletown, Pennsylvania.

- Performed system checks and operation at groundwater remediation sites, hazardous materials sampling and preparation, well purging, sampling, and recharge calculations.

***Professional Activities***

Member, Society of Petroleum Engineers
Member, Society of Organic Petrology

***Publications***

Has coauthored several publications.

**DR. LU JIN**
Distinguished Reservoir Engineer
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5316, ljin@undeerc.org

***Education and Training***

Ph.D., Petroleum Engineering, Louisiana State University, 2013.
M.S., Petroleum Engineering, Louisiana State University, 2009.
B.S., Petroleum Engineering, Northeast Petroleum University, 2005.

***Research and Professional Experience***

**October 2022–Present:** Distinguished Reservoir Engineer, EERC, UND.

- Develops novel methods for renewable energy development in Williston Basin, including geothermal development in Bakken Formation and hydrogen conversion in oil reservoirs.
- Serves as task lead and key reservoir engineer for U.S. Department of Energy (DOE)-sponsored project, "Williston Basin Resource Study for Commercial-Scale Subsurface Hydrogen Storage."
- Leads scientific research activities on machine learning applications, enhanced oil recovery (EOR) technologies, database development for EOR operations, effective simulation methods for unconventional reservoirs, etc.
- Serves as principal investigator (PI) for North Dakota Industrial Commission (NDIC)-sponsored project, "Extending the Shale Revolution from Oil and Gas to Geothermal Development in North Dakota."
- Serves as PI for NDIC-sponsored project, "Examination of In Situ Hydrogen Conversion in Oil Reservoirs."
- Serves as task lead and key reservoir engineer for U.S. Department of Energy (DOE)-sponsored project, "$CO_2$ Enhanced Oil Recovery Improvement in Conventional Fields Using Rich Gas."
- Serves as task lead and key reservoir engineer for DOE-sponsored project, "Improving Enhanced Oil Recovery Performance Through Data Analytics and Next-Generation Controllable Completions."
- Serves as task lead and key reservoir engineer for NDIC-sponsored project, "Unitized Legacy Oil Fields: Prototypes for Revitalizing Conventional Oil Fields in North Dakota."

Principal areas of interest and expertise include reservoir modeling and simulation, $CO_2$/rich gas EOR and associated $CO_2$ storage in both conventional and unconventional reservoirs, engineering optimization, water coning control, and multiphase flow in porous media, with particular interest in subsurface oil–water–gas interactions, EOR techniques and development of old oil fields/unconventional resources.

**January 2020–September 2022:** Principal Reservoir Engineer, EERC, UND.

- Developed dynamic numerical models for $CO_2$/rich gas enhanced oil recovery in different reservoirs.
- Oversaw technical areas in reservoir engineering, including conventional, unconventional and enhanced oil and gas production, geologic storage of $CO_2$ and natural gas, natural resource development, geocellular modeling, numerical simulation.

- Served as task lead and key reservoir engineer for DOE-sponsored project, "$CO_2$ Enhanced Oil Recovery Improvement in Conventional Fields Using Rich Gas."
- Served as task lead and key reservoir engineer for DOE-sponsored project, "Improving Enhanced Oil Recovery Performance Through Data Analytics and Next-Generation Controllable Completions."
- Served as key reservoir engineer for DOE-sponsored project, "Bakken Rich Gas Enhanced Oil Recovery Project."
- Served as co-PI for NDIC-sponsored project, "Exploration of Opportunities and Challenges for a North Dakota Petrochemical Industry."

**July 2018–January 2020:** Senior Reservoir Engineer, EERC, UND.

- Developed dynamic numerical models for CO2 flow monitoring and prediction in different reservoirs; designed well testing plans for both producers and injectors to support long-term success of field operations; developed innovative fractured reservoir models for Bakken unconventional petroleum system; and served as simulation task lead for variety of seismic projects.
- Served as task lead and key reservoir engineer for DOE-sponsored project, "Joint Inversion of Time-Lapse Seismic Data."
- Served as key reservoir engineer for DOE-sponsored project, "Scalable, Automated, Semi-permanent Seismic Method for Detecting $CO_2$ Plume Extent During Geological $CO_2$ Injection – Phase II."

**February 2015–July 2018**: Reservoir Engineer, Reservoir Modeling and Simulation, EERC, UND.

- Developed geophysical models of subsurface and ran dynamic simulations to determine long-term fate of produced/injected fluids, including hydrocarbons, $CO_2$ storage, and brine, using oil and gas industry simulation software.
- Served as task lead and key reservoir engineer for DOE-sponsored project, "Plains $CO_2$ Reduction (PCOR) Partnership Phase III – Bell Creek Test Site."
- Served as Co-PI and key reservoir engineer for DOE-sponsored project, "Improved Characterization and Modeling of Tight Oil Formations for $CO_2$ Enhanced Oil Recovery Potential and Storage Capacity Estimation."
- Served as key reservoir engineer for DOE-sponsored project, "Scalable, Automated, Semi-permanent Seismic Method for Detecting $CO_2$ Plume Extent During Geological $CO_2$ Injection – Phase I."

**January 2014–January 2015**: Reservoir Engineer, InPetro Technologies, Inc., Houston, Texas.

- Developed simulation and analytical models for unconventional reservoir development, especially for shale oil reservoirs; analyzing fluid PVT (pressure, volume, temperature) change during depletion and considering pore-size distribution (PSD) in simulations. Application of new model in Eagle Ford and Bakken Formations shows that oil reserves could be improved as much as 30% by integrating PVT and PSD effects.

**August 2007–December 2013**: Research Assistant and Reservoir Consultant, Department of Petroleum Engineering, Louisiana State University (LSU), Baton Rouge, Louisiana.

- Modeled and evaluated performance of downhole water loop (DWL) well system in different oil fields, developed economical models for evaluation of DWL system in various reservoir and market conditions, and identified best reservoir candidates for system; oil production rate could be improved as much as 200%. Constructed software (toolbox) using ECLIPSE and VBA for complex well system simulation, applied batch processing technology in simulation, achieved automatic task queuing, and reduced simulation time 67%.

**January 2013–December 2013**: Reservoir Consultant, Joint Industrial Program (JIP), LSU, and Pluspetrol, Baton Rouge, Louisiana. Simulated cold production of heavy oil in Massambala Field, Angola, identifying mechanisms of high water cut in current wells, optimizing perforation length for conventional wells, and proposing two well systems, which could improve cumulative oil up to 80% or reduce produced water 75%, respectively.
**May 2012–August 2012**: Internship, High Plains Operating Company, LLC (HPOC), San Francisco, California. Simulated and analyzed extra water production problems in Ojo Encino Field, New Mexico, designing DWS well system to produce oil from thick transition zone, which could improve oil production rate by up to 20%.
**May 2011–August 2011**: Internship, JIP, LSU, and HPOC, Baton Rouge, Louisiana. Simulated performance of vertical and horizontal wells in Ojo Encino Field, New Mexico, diagnosing water coning/cresting problems in thick transition zone, determining best location for water injection to minimize pressure interference, and suggesting well type to develop field, which saved costs up to 30%.
**January 2011–January 2013**: Senior Teaching Assistant, Drilling Fluids Laboratory, LSU, Baton Rouge, Louisiana. Served as lecturer and oversaw four teaching assistants and 80–100 students each year as well as supervised three senior students completing their senior design projects.

**September 2005–August 2007**: Production Consultant, JIP, China University of Petroleum, and CNPC.

- Optimized a large gas pipeline network in China, proposed new optimization algorithm, and programmed software package for best operation in different conditions, reducing operational cost up to 23% (more than $20,000/day).

***Professional Activities***
Member, Society of Petroleum Engineers

***Publications***
Has authored or coauthored numerous peer-reviewed and other professional publications.

**DR. NIDHAL BADROUCHI**
Senior Research Scientist
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5488, nbadrouchi@undeerc.org

***Education and Training***

Ph.D., Petroleum Engineering, University of North Dakota, 2022.
MEng., Petroleum Engineering, University of North Dakota, 2019.
M.Sc., Chemical Process Engineer, National Engineering School of Gabes, Tunisia, 2013.
Engineering Cycle Preparatory Studies, National Institute of Applied Sciences and Technologies of Gabes, Tunisia, 2010.
Language proficiencies: Arabic (native), French and English (fluent), and German (basic).
Computer proficiencies: Microsoft Office Suite, LOTUS, Hysys, Aspen plus, Aspen HTFS, CMG, and KAPPA.

***Research and Professional Experience***

**April 2023–Present:** Senior Research Scientist, EERC, UND.

- Collaborates on research proposal writing and leads experimental efforts to support research activities related to enhanced oil recovery (EOR) in unconventional and conventional formations, geomechanics, and subsurface storage of $CO_2$ and/or rich gas.

Principal areas of interest and expertise include reservoir engineering, fluid flow in porous media, rock mechanics, $CO_2$ storage and utilization, and EOR.

**August 2022–March 2023:** Research Scientist, EERC, UND.

- Conducted laboratory analyses and interpreted lab data to support research activities related to improved production of unconventional oil and gas reservoirs, EOR in unconventional and conventional formations, geomechanics, and subsurface storage of $CO_2$ and/or rich gas.

**August 2020–July 2022:** Research Assistant, EERC, UND.

- Ran experiments related to gas injection.

**September 2018–August 2020:** Graduate Research Assistant, Department of Petroleum Engineering, UND.

- Coordinated advanced petroleum engineering lab work and ran experiments and simulations related to $CO_2$ EOR in the Bakken.

**June 2015–April 2018:** Production Team Leader, NEJMA, Tunis, Tunisia.

- Planned and ensured production sustainability and conformity regarding quality standards.

**July 2013–May 2015:** Professional Intern, ETAP (NOC of Tunisia), Tunis, Tunisia.

- Studied the design of a natural gas separation and compression unit.
-

**March–June 2013:** Graduate Project, British Gas Tunisia (now Shell Tunisia), Tunis, Tunisia.

- Worked on graduate project entitled Reduction of Energetic Consumption and Related Polluting Gases Emissions of a Gas Processing Plant.

**July 2012:** Summer Intern, STIR, Bizerte, Tunisia.

***Publications***

Has coauthored several professional publications.

**MICHAEL P. WARMACK**
Distinguished Oil and Gas Facilities Engineer
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5004, mwarmack@undeerc.org

***Education and Training***
B.S., Chemical and Petroleum Refining Engineering, Colorado School of Mines, 1981.

***Research and Professional Experience***
**2022–Present:** Distinguished Oil and Gas Facilities Engineer, EERC, UND.

- Serves on EERC project teams and works with EERC clients by providing technical leadership/oversight on industrial and governmental projects relating to enhanced oil recovery (EOR) and carbon capture, utilization, and sequestration (CCUS) projects to improve development and production of domestic energy.
- Supports planning, design, selection of materials/treatment programs, costing, reporting, and/or upgrade/retrofit efforts related to production facilities optimization for unconventional oil plays; injection, production, and recycle infrastructure associated with EOR/incremental oil recovery (IOR) in conventional and unconventional oil and gas plays; infrastructure associated with capture and injection of $CO_2$ for geologic storage; and other emerging challenges associated with oil and gas injection/production processes.
- Has more than 40 years of experience in oil and gas production and operations, facilities design and installation, chemical treatment and optimization, and hands-on experience in multiple engineering disciplines.

**2021–2022:** Principal Oil and Gas Facilities Engineer, EERC, UND.

- Served on EERC project teams and worked with EERC clients to improve development and production of domestic energy.
- Supported planning, design, selection of materials/treatment programs, costing, reporting, and/or upgrade/retrofit efforts related to production facilities optimization for unconventional oil plays; injection, production, and recycle infrastructure associated with EOR/IOR in conventional and unconventional oil and gas plays; infrastructure associated with capture and injection of $CO_2$ for geologic storage; and other emerging challenges associated with oil and gas injection/production processes.

**2015–2020:** Denbury Resources, Plano, Texas.
Was directly involved with Denbury's $CO_2$ operations within Delhi EOR and natural gas liquids (NGL) facilities (Delhi, Louisiana) and Tinsley EOR unit (Tinsley, Mississippi). Positions held included the following:

Facilities and Optimization Engineer – Delhi EOR Unit

- Provided engineering support on operations for Delhi EOR and NGL facilities.

- Provided recommendations and designs for facility upgrades (EOR facility), new equipment installation (EOR and NGL facilities), programming changes to plant operations, and operational changes within facilities. Efforts resulted in increased operational run time of plant and field operations while providing more efficient separation through plant.
- Worked with vendor on operations of NGL plant, resulting in equipment upgrades and increasing run time of plant from 85% in 2018 to 95% in 2019.
- Initiated monthly mechanical integrity and chemical reviews of plant and field operations.
- Designed and installed oil line to third-party crude blending facility, resulting in additional revenues without costs to unit.

Facilities and Optimization Engineer – Tinsley EOR Facility

- Provided detailed engineering review and recommendations for reducing chemical treatments on injection wells and improving operations of Tinsley EOR facility. Recommendations reflected development of maximum operating rate of EOR facility in terms of momentum, culminating in $9.2 million investment to upgrade plant. After completion of plant upgrades, injection well treatments were reduced from 40+ treatments/month to ~1 per month while reducing treating chemical expenses by approximately $2.4 million per year.
- Led engineering review on reduced injection occurring in field. Provided detailed analysis on injection system resulting in recommendation to improve flow in two major distribution lines.
- Instituted monthly mechanical integrity and chemical treating reviews on field operations.

**2001–2015:** Chaparral Energy, Oklahoma City, Oklahoma.
Directly involved with Chaparral's EOR operations in Texas and Oklahoma Panhandle areas, northeast Oklahoma area, and primary production activities in Oklahoma and Texas Panhandle areas. Positions held included the following:

Facilities Advisor/Facilities Manager (2011–2015)

- Provided project management and engineering oversight for Chaparral's largest $CO_2$ development that included grassroots 68-mile $CO_2$ pipeline and grassroots $CO_2$ capture facility to serve new EOR project in northeast Oklahoma.
- Directly responsible for facility design and integration within all of Chaparral's ongoing and developing EOR projects, resulting in alternative design of field facilities to replace underperforming equipment.
- Initiated standardization of facility designs within EOR projects for compression, water facilities, $CO_2$ pumps, and cooling facilities.
- Directly involved with developing and maintaining Chaparral's EOR budget, including full field project development costs.
- Recognized as key contributing team member by leading Chaparral in achieving its initial and highest monthly oil production level of 1 MMBO in May 2014.

Operations Manager/Operations Engineer (2001–2011)

- Directly responsible for development of Chaparral's $CO_2$ expansion programs within active and three new EOR projects within Oklahoma and Texas Panhandle areas. Development work included well intervention, facilities design and installation, chemical reviews on ongoing operations, drilling, and completion programs, WAG design and implementation, and land work support. Chaparral's $CO_2$ expansion programs realized increase in gross production of over 5100 BOPD from nits involved.

- Directly responsible for securing $CO_2$ sourcing from Arkalon ethanol plant in Liberal, Kansas, resulting in development of grassroots $CO_2$ capture facility adjacent to ethanol plant.
- Directly responsible for development, installation, and monitoring of three pipeline projects in southwest Kansas and Oklahoma and Texas Panhandle areas to service new $CO_2$ projects.
- Instituted chemical squeeze treatment on submersible pump installations to stem scaling of downhome equipment. Treatments resulted in increasing run time of submersible pumps from less than 3 months to 18 months.
- Recognized by Chaparral as key personnel asset within its EOR operations during Chaparral's financial presentations.

**1999–2001:** WoodGroup ESP, Oklahoma City and Purcell, Oklahoma.
Alliance Manager (2000–2001)

- Directly responsible for alliance with Kerr McGee for submersible pump installation and operation.
- Instituted new design parameters on submersible pump installations that dramatically increased run time of installed equipment. This design resulted in savings of over $1 million per year to Kerr McGee. Recognized by Kerr McGee for savings to its operations.
- Developed plan for continuous improvement concerning submersible pump installations based upon review of equipment installations and cooperation of WoodGroup's personnel and Kerr McGee's Failure Analysis Team.

Reliability Engineer (1999–2000)

- Directly responsible for investigation into failures on domestic and international customer equipment. Provided summary reports of findings with proposed solutions to prevent future reoccurrence.
- Directly responsible for investigative review on WoodGroup's operating standards, equipment upgrades, and modifications.
- Provided engineering support to in-house quality control on procured and manufactured equipment.

**1997–1998**: Lead Field Engineer, Occidental Petroleum, Maracaibo, Venezuela.

- Supervised staff of up to 15 field personnel engaged in completions, nondrilling workovers, and downhole operations.
- Coordinated fieldwork with Maracaibo office and camp personnel for workover and production operations, submersible equipment design and installation, and workover rig movements.
- Recognized as key asset in ongoing operations through sale of operations from Occidental to Union Texas Petroleum to Arco and British Petroleum.

**1981–1997:** Occidental Petroleum and prior subsidiaries, Oklahoma City, Oklahoma.

- Directly involved with ongoing EOR projects in central Oklahoma area that included design of grassroots EOR project in acquired unit for plant and field facilities. Instituted new design for $CO_2$ distribution system within field.
- Implemented Failure Analysis Team (FAT Team) to extend run time of submersible pump installations within company's EOR operations. FAT Team consisted of operating personnel, a chemical supplier, and a submersible pump supplier. Work from FAT Team resulted in extending run times of submersible pumps from 15 months to over 24 months within 2 years, resulting in reduced operating and equipment costs.
- Led successful acquisition efforts on two producing properties valued at $3.0 million. Directly involved with unsuccessful acquisition of two companies.

- Continuously enhanced production base from wells ranging in depths from 3000 to 15,000 feet through workover programs, recompletions, stimulations, and changes in artificial lift equipment. Developed and instituted program for having pipeline connection installed prior to frac treatments, resulting in better completions and higher production from wells.
- Developed multistage frac design in vertical wells using bullet perforations, reducing frac time by 50% and resulting in savings of over $250,000 per job.
- Selected by Oxy to serve on worldwide ESP team to enhance run time and use of ESP equipment.

***Publications***

Has coauthored numerous professional publications.

**RYAN MCGUIGAN**
Reservoir Engineering Director
Chord Energy
713.303.2966, ryan.mcguigan@chordenergy.com

***Education and Training***

Ph.D. Candidate, Petroleum Engineering, University of Texas, estimated graduation: 2028.
M.S., Petroleum Engineering, University of Houston, 2014.
B.S., Petroleum Engineering, Texas Tech University, 2007.

***Research and Professional Experience***

**2020–Present:** Reservoir Engineer Director, Chord Energy.

- Manage a team of four reservoir engineers.
- Technical lead for all development planning in the Willison Basin.
- Technical lead for all in-basin acquisitions and divestitures.
- Technical lead for all subsurface studies.

**2017–2020:** Permian Asset Manager, Chord Energy.

- Managed a team of three reservoir engineers.
- Led all planning efforts for the Business Unit.
- Responsible for drill readiness and rig line scheduling.

**2014–2017:** Reservoir Engineering Manager, Chord Energy.

- Leadership and management responsibility for five reservoir engineers and two technicians.
- Led all development planning in the Williston Basin.
- Technical lead for all subsurface studies.

**2013–2014:** Reservoir Engineer, Chord Energy.

- Designed development plans for parts of the Williston Basin.
- Managed subsurface studies for the asset team:
  - Core and log capture/analysis
  - Pressure observation wells
  - Diagnostic fracture injections tests
  - Numerical stimulation and analytical well testing
  - Original oil in place (OOIP) calculations (unique challenges in the Bakken petroleum system)

**2008–2013:** Reservoir Engineer, Oxy USA Inc.

- Southwest Kansas – development planning, production optimization, completion operations support, and drilling operations support.
- Permian Basin – development planning.

**2007–2008:** Fracture Stimulation Engineer, BJ Services.

- On-site quality assurance/quality control (QA/QC) of fracture fluid systems and design recommendations.

***Relevant Publications***
None.

***Synergistic Activities***
None.

# APPENDIX B

# COST-SHARE COMMITMENT LETTERS

Chord Energy

October 31, 2024

Dr. John Harju
Vice President for Strategic Partnerships
Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Dear Dr. Harju:

Subject: Chord Energy LLC. – Letter of Interest for the Project Entitled "Injection Testing with Propane to Inform Future Bakken $CO_2$ EOR Pilot"

Chord Energy LLC (Chord) is interested in potentially working with the Energy & Environmental Research Center (EERC) in the subject proposed project to conduct a propane-based injection test into a Bakken well tentatively planned for summer of 2025. The proposed propane injection test being considered by Chord would be conducted in the same Bakken reservoir (Grail Field, McKenzie County) that has been chosen to host a large-scale carbon dioxide ($CO_2$) enhanced oil recovery (EOR) pilot test, currently anticipated to be initiated in late 2026 or early 2027. Conducting a propane injection test in the Grail Field Bakken reservoir prior to the larger $CO_2$ pilot, and the proposed laboratory and modeling efforts to support the propane injection test, would generate data that would inform Chord's decisions regarding the detailed design and operation of the injection scheme for the future large-scale $CO_2$ EOR pilot. In particular, the proposed lab, modeling, and field activities would be anticipated to yield critical information to ground-truth injectivity and reservoir response to injection, which in turn would inform proper selection and sizing of infrastructure design and equipment, including compression and flowback management equipment.

Chord is considering providing in-kind cost sharing to the proposed propane injection test program. In-kind contributions may include, but would not necessarily be limited to, acquisition and delivery of propane, procurement of the equipment and infrastructure, and contracting with the necessary oilfield service providers to execute the test. Should Chord decide to move forward with the proposed test, it is anticipated that the value of those contributions could exceed $2,200,000.

We look forward to continued discussions with the EERC to further advance the ultimate goal of broad commercial deployment of EOR in North Dakota. This letter, evidencing Chord's interest in the captioned project, does not create any obligation on the part of Chord to fund or participate in the project and no such obligation by Chord shall exist until Chord and the EERC mutually execute a written definitive and binding agreement covering the same.

Should you have any questions, please do not hesitate to contact me by phone at (281) 404-9671 or by email at Alex.Wall@chordenergy.com.

Sincerely,

Alex Wall
Vice President, Asset Management

# APPENDIX C

# BUDGET JUSTIFICATION

# BUDGET JUSTIFICATION

## ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

### BACKGROUND

The EERC is an independently organized multidisciplinary research center within the University of North Dakota (UND). The EERC is funded through federal and nonfederal grants, contracts, and other agreements. Although the EERC is not affiliated with any one academic department, university faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

### INTELLECTUAL PROPERTY

The applicable federal intellectual property (IP) regulations will govern any resulting research agreement(s). In the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this project, such IP, including rights, title, interest, and obligations, may be transferred to the EERC Foundation, a separate legal entity.

### BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only. The project manager may incur and allocate allowable project costs among the funding sources for this scope of work in accordance with Office of Management and Budget (OMB) Uniform Guidance 2 CFR 200.

Escalation of labor and EERC recharge center rates is incorporated into the budget when a project's duration extends beyond the university's current fiscal year (July 1 – June 30). Escalation is calculated by prorating an average annual increase over the anticipated life of the project.

The cost of this project is based on a specific start date indicated at the top of the EERC budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

**Salaries:** Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the average rate of a personnel group with similar job descriptions. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project may be paid an amount over the normal base salary, creating an overload which is subject to limitation in accordance with university policy. As noted in the UND EERC Cost Accounting Standards Board Disclosure Statement, administrative salary and support costs which can be specifically identified to the project are direct-charged and not charged as facilities and administrative (F&A) costs. Costs for general support services such as contracts and IP, accounting, human resources, procurement, and clerical support of these functions are charged as F&A costs.

**Fringe Benefits:** Fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services. This portion of the rate covers vacation, holiday, and sick leave (VSL) and is applied to direct labor for permanent staff eligible for VSL benefits. Only the

actual approved rate will be charged to the project. The second component is estimated on the basis of historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

**Travel:** Travel may include site visits, fieldwork, meetings, and conferences. Travel costs are estimated and paid in accordance with OMB Uniform Guidance 2 CFR 200, Section 474, and UND travel policies, which can be found at https://campus.und.edu/finance/procurement-and-payment-services/travel/travel.html (Policies & Procedures, A–Z Policy Index, Travel). Daily meal rates are based on U.S. General Services Administration (GSA) rates unless further limited by UND travel policies; other estimates such as airfare, lodging, ground transportation, and miscellaneous costs are based on a combination of historical costs and current market prices. Miscellaneous travel costs may include parking fees, Internet charges, long-distance phone, copies, faxes, shipping, and postage.

**Supplies:** Supplies include items and materials that are necessary for the research project and can be directly identified to the project. Supply and material estimates are based on prior experience with similar projects. Examples of supply items are chemicals, gases, glassware, nuts, bolts, piping, data storage, paper, memory, software, toner cartridges, maps, sample containers, minor equipment (value less than $5000), signage, safety items, subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the F&A cost.

**Subcontractor – Chord Energy:** Chord Energy (Chord) is an independent energy company that acquires, develops, and explores for crude oil, natural gas, and natural gas liquids in the Williston Basin. Chord will conduct the propane injection activities in the field. Estimated costs for the field-based activities include, but are not necessarily limited to, purchase of propane, propane transportation costs, pumping costs, downhole work, and surface work to support the execution of the injection test. This proposal requests that $800,000 of NDIC OGRP funding goes towards paying for costs incurred by Chord over the course of site preparation and injection test operations.

**Consultant – Gordon Pospisil:** Gordon Pospisil is an independent petroleum engineer consultant. Mr. Pospisil will be providing advice on the design of the injection and the interpretation of the results.

**Printing and Duplicating:** Page rates are established annually by the university's duplicating center. Printing and duplicating costs are allocated to the appropriate funding source. Estimated costs are based on prior experience with similar projects.

**Operating Fees:** Operating fees generally include EERC recharge centers, outside laboratories, and freight.

EERC recharge center rates are established annually and approved by the university.

Laboratory and analytical recharge fees are charged on a per-sample, hourly, or daily rate. Additionally, laboratory analyses may be performed outside the university when necessary. The estimated cost is based on the test protocol required for the scope of work.

Document production services recharge fees are based on an hourly rate for production of such items as report figures, posters, and/or images for presentations, maps, schematics, Web site design, brochures, and photographs. The estimated cost is based on prior experience with similar projects.

Technical software is a use fee for an advanced project management tool. Costs are associated with software, data entry, maintenance, and enhancement of the system software.

Field safety fees cover safety training and certifications, providing necessary PPE, and annual physicals. The estimated cost is based on the number of days individuals are budgeted to work in the field.

Geoscience services recharge fees are discipline fees for costs associated with training, certifications, continuing education, and maintaining required software and databases. The estimated cost is based on the number of hours budgeted for this group of individuals.

**Facilities and Administrative Cost:** The F&A rate proposed herein is approved by the U.S. Department of Health and Human Services and is applied to modified total direct costs (MTDC). MTDC is defined as total direct costs less individual capital expenditures, such as equipment or software costing $5000 or more with a useful life of greater than 1 year, as well as subawards in excess of the first $25,000 for each award.

**Cost Share:** Chord Energy has committed to providing $2,200,000 of in-kind cost share.

# APPENDIX D

# STATUS OF ONGOING PROJECTS LIST

**STATUS OF ONGOING PROJECTS LIST**

| Project Title | Contract Award No. |
|---|---|
| Bakken Production Optimization Program 4.0 | G-058-115 |
| Improving EOR Performance Through Data Analytics and Next-Generation Controllable Completions | G-050-97 |
| iPIPE: The Intelligent Pipeline Integrity Program | G-046-88 |
| iPIPE 3.0: The Intelligent Pipeline Integrity Program | G-059-116 |
| PCOR Initiative to Accelerate CCUS Deployment | G-050-96 |