

March 29, 2021

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


Dear Ms. Fine:

Subject: Request to Initiate NDIC OGRP Project Entitled “Unitized Legacy Oil Fields: Prototypes for Revitalizing Conventional Oil Fields in North Dakota”

Eagle Energy Partners Tundra, LLC, is excited to proceed with the North Dakota Oil and Gas Research Program (OGRP)-approved, and North Dakota Industrial Commission (NDIC)-awarded, project entitled “Unitized Legacy Oil Fields: Prototypes for Revitalizing Conventional Oil Fields in North Dakota.” Eagle Energy Partners Tundra has satisfied the condition of the award by acquiring the Foreman Butte oil field in McKenzie County, North Dakota, which is producing from the Ratcliff Interval of the Madison Formation as the qualified candidate oil field at which to conduct the project. Eagle Energy Partners Tundra has operating control and a majority working interest in the Foreman Butte Field, satisfying the provision placed by the OGRP at the time of award.

Attached is an updated OGRP Application Package that is amended to reflect the acquisition and specification of the Foreman Butte oil field as the project field site; a revised project start date of July 1, 2021; a renewed letter of commitment from project partner The Energy & Environmental Research Center; and a business name change from Eagle Energy Partners I, LLC, to Eagle Energy Partners Tundra, LLC. The objectives, scope of work, level of effort, project timeline, and commitment remain preserved.

Eagle Energy Partners Tundra and our project partners have the desire and ability to conduct the referenced OGRP project that we believe provides long-lasting economic and technical benefits to the State of North Dakota that far exceed the \$3 million investment. Eagle Energy Partners Tundra and partners are excited to proceed and are committed to providing the professional and financial resources necessary to execute the project as described.

Sincerely,  
DocuSigned by:  
  
~~Pat Nickodemus~~  
Vice President of Operations

RM

Attachment

c/att: Brent Brannan, NDIC  
Lynn Helms, NDIC  
Ron Ness, North Dakota Petroleum Council

## Oil and Gas Research Program

North Dakota

Industrial Commission



## Application

**Project Title:** Unitized Legacy Oil Fields:

Prototypes for Revitalizing Conventional Oil Fields  
in North Dakota

**Applicant:** Eagle Energy Partners Tundra (EEP  
Tundra, LLC)

**Principal Investigator:** Pat Nickodemus

**Date of Application:** February 14, 2018  
(Amended March 25, 2021)

**Amount of Request:** \$3,000,000

**Total Amount of Proposed Project:** \$6,000,000

**Duration of Project:** 36 months

**Point of Contact (POC):** Pat Nickodemus

**POC Telephone:** (907) 556-0814

**POC E-Mail Address:**

pat@eagleenergypartnersllc.com

**POC Address:**

2501 6th Street Southeast, Suite B

Minot, ND 58701

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## ABSTRACT

Eagle Energy Partners Tundra (EEP Tundra) proposes a multidisciplinary research program to address technical challenges facing revitalization of conventional reservoirs in North Dakota. EEP Tundra will investigate the unitized Forman Butte oil field producing from the Madison Group (or other suitable production horizons) as a prototype for implementing CO<sub>2</sub> enhanced oil recovery (EOR) in North Dakota. EEP Tundra will conduct the program in close collaboration with the Energy & Environmental Research Center (EERC). Information generated in this project will positively affect ultimate recovery from North Dakota's conventional oil pools and will lead to additional projects, processes, ideas, and activities to facilitate implementation of oil exploration and production technologies presently not used in the state. The potential to revitalize conventional oil fields and increase ultimate recovery will bring new investment to North Dakota, resulting in the growth of oil and gas jobs, wealth, and tax revenues.

**Objective:** Investigate waterflood optimization as a precursor for CO<sub>2</sub> EOR and development pathways for the Foreman Butte oil field producing from the Madison Group as a prototype for the revitalization of analogous conventional oil fields in North Dakota. Major objectives to be accomplished to meet the stated goal are to 1) evaluate waterflood optimization and CO<sub>2</sub> EOR potential and implementation approaches specific to the Madison or other suitable production horizons; 2) develop cost-effective operational strategies that address key technical challenges, optimize current facilities, and systematically consider necessary new facilities; and 3) frame the results from this project as a prototype for revitalizing analogous conventional oil fields in North Dakota in anticipation of tertiary CO<sub>2</sub> EOR.

**Expected Results:** New information to enable operators, investors, regulators, and other stakeholders to make informed decisions regarding the revitalization of North Dakota's vast conventional oil resources.

**Duration:** 36 months (July 1, 2021, to June 30, 2024).

**Total Project Cost:** \$6,000,000. The amount requested from the Oil and Gas Research Program (OGRP) is \$3,000,000. At least \$3,000,000 in cofunding will be provided by EEP Tundra.

**Participants:** EEP Tundra and the EERC (EERC letter of commitment is in Appendix A).

## PROJECT DESCRIPTION

**Objectives:** Recent studies indicate 280 MMbbl to over 630 MMbbl of incremental oil recovery potential through the use of tertiary CO<sub>2</sub> EOR in 86 North Dakota unitized conventional oil fields (NDLM, 2014). The goal of the proposed research program is to enable revitalization of unitized conventional oil fields in North Dakota, ultimately resulting in increased daily oil production and prolonging the operational lifetime of those fields. The three major objectives to meet this goal are to 1) evaluate waterflood optimization and CO<sub>2</sub> EOR potential and implementation approaches specific to Madison producing field(s) or other legacy conventional fields producing from suitable horizons; 2) explore operational strategies that address key technical challenges, optimize current facilities, and systematically consider necessary new facilities; and 3) frame project results and experiences as a prototype for revitalizing analogous conventional oil fields in North Dakota in anticipation of CO<sub>2</sub> EOR.

The first objective will be achieved by using new and existing geologic and reservoir engineering characterization data (e.g., core analyses, well logs, oil analyses) and modeling/simulation to optimize waterflood operations in preparation of near-term CO<sub>2</sub>-based EOR operations. To achieve the second objective, results of new characterization and geologic assessments will be combined with refined performance forecasts to conduct CO<sub>2</sub> EOR scenario analysis. The results will be used to develop strategies for the design and operation of prudent EOR schemes that will be applicable to other unitized fields producing from similar pools. The third objective will be achieved through the synthesis of the project results into a guidance document for producers and investors looking to revitalize analogous conventional unitized fields in North Dakota with CO<sub>2</sub>-based EOR.

Many Madison fields have been under waterflood since the early 1970s and are promising candidates for CO<sub>2</sub> EOR (Burke, 2005; NDLM, 2014). In total, 86 unitized legacy oil fields producing from the Madison Group (and other suitable producing horizons) have been identified as potential near-term CO<sub>2</sub> EOR candidates (Figure 1). The information generated from the proposed investigation will be directly applicable to many of these analogous fields. North Dakota has no commercial tertiary CO<sub>2</sub> EOR

operations currently, and the knowledge gained through the proposed research will serve to derisk the implementation of future CO<sub>2</sub> EOR projects and thus attract investment in the North Dakota oil and gas industry. Applying project results to other fields may bring new CO<sub>2</sub> EOR activity to the state, resulting in a significant contribution to OGRP goals and Governor Burgum's challenge of producing 2 MMbpd of oil. The proposed research will contribute to the development of North Dakota's endowment of oil and benefit areas of the state beyond the extent of current Bakken petroleum system (BPS) production.

**Methodology:** EEP Tundra will work closely with the EERC to

implement a research program that includes detailed geologic characterization and to develop infrastructure and operating

strategies to optimize waterflood operations as a precursor to CO<sub>2</sub> EOR. Key findings of the project will be integrated into a prototype field development plan that informs a guidance document to revitalize conventional reservoirs. The activities in the proposed project are organized within two tasks.

### **Task 1. Assessing the Potential of a Unitized Legacy Oil Field**

**Subtask 1.1. Data Reconnaissance and Conditioning.** Much of the data needed to accurately and successfully complete the goal of the proposed project is available through either publicly available sources (e.g., North Dakota Industrial Commission [NDIC] database, scholarly studies) or will be available from EEP Tundra. EEP Tundra is the operator of the Foreman Butte oil field producing from the Madison Group, a top EOR and environmental, social, and governance (ESG)-compliant project candidate suitable for use as a prototype for the revitalization of analogue conventional oil fields in North Dakota. A gap analysis process will identify missing key data and guide new data acquisition. Existing data (e.g., well logs, well files, core data, fluid and rock properties) are anticipated to be in a variety of

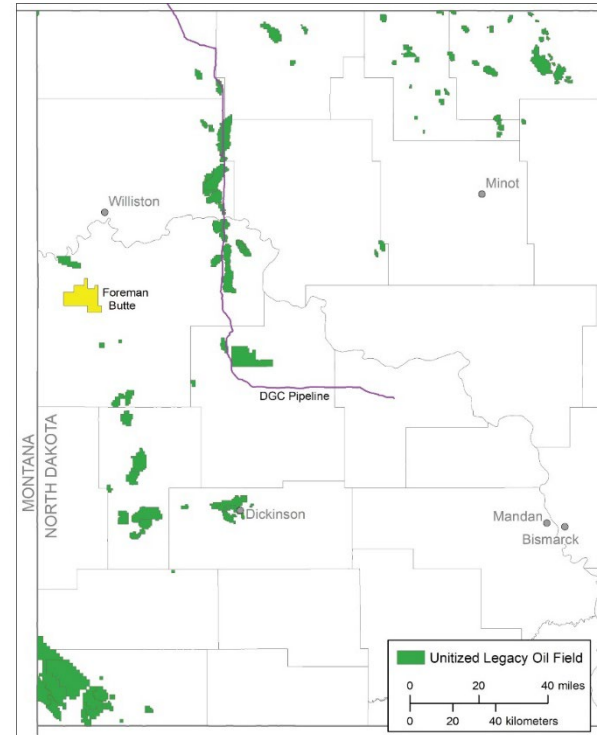


Figure 1. Unitized legacy oil fields identified as near-term candidates suitable for CO<sub>2</sub> EOR (NDLM, 2014).

formats and will require conditioning prior to use. Subtask 1.1 comprises the activities to compile, organize, manage, screen, vet, digitize, and interpret the various types of data for integration into Subtasks 1.2 and 1.3 and reporting.

**Subtask 1.2. Reservoir Modeling and Engineering.** Subtask 1.2 activities include geologic and engineering characterization of the study field. Geologic and simulation models representative of the geology and physical performance of the producing horizon will be constructed, history-matched, and calibrated. The geologic and simulation models will be assessed based on sensitivity and uncertainty in performance to define and prioritize data needs to be addressed through Subtask 1.4. New field and laboratory data produced through Subtask 1.4 will refine the geologic and simulation models. EEP Tundra and EERC experience with waterflood and CO<sub>2</sub> EOR projects, combined with simulated performance data from scenario analyses, will define and evaluate development strategies and operating scenarios to optimize waterflood performance as a precursor to CO<sub>2</sub> EOR.

**Subtask 1.3. Operability Assessment.** Existing facilities, infrastructure, and data monitoring used in the Foreman Butte oil field will be assessed with the development strategies and operating scenarios investigated in Subtask 1.2. Data collection, management, and a facility upgrade plan for the fields will be developed.

**Subtask 1.4. Strategic Characterization.** Based on the results of Subtasks 1.2 and 1.3, new data will be collected, analyzed, and interpreted (e.g., well logs, pressure testing, production profiles, core testing) to support the research program. Results will be integrated into Subtask 1.2 to calibrate and improve geologic and simulation model performance and in Subtask 1.3 to ultimately evaluate operating scenarios and inform development strategies to revitalize the selected field.

**Task 2. Prototype to Revitalize a Unitized Legacy Oil Field.** Task 2 will synthesize Task 1 activities and results (e.g., performance response derived from scenario analysis) to assess potential development strategies for CO<sub>2</sub> EOR that can be applied to revitalize analogue legacy oil fields in North Dakota. This information will be incorporated into a guidance document and included as part of the final report (D6).

**Proposed Deliverables (D)**

**D1 – Quarterly Reports:** Quarterly progress reports will be submitted to NDIC 30 days after the end of each calendar quarter.

**D2 – Data Needs Analysis – Priorities for Revitalization:** Based on EEP Tundra and EERC experience, combined with geologic and simulation model results, a list of required/preferred geologic and operational data to characterize a reservoir for waterflood and CO<sub>2</sub> EOR will be compiled. Using this compilation, a gap analysis will be performed to ascertain data needs required to revitalize the study field using CO<sub>2</sub> EOR. These needs will be prioritized based on intended use, scarcity, cost, and benefits. A document (D2) will be created describing this process that can be applied by operators seeking to revitalize similar oil fields in North Dakota. D2 will be provided to NDIC at the end of Year 1.

**D3 – Facilities Assessment – Opportunities and Challenges for Revitalization:** Based on EEP Tundra and EERC experience, a list of required/preferred infrastructure for the operation and management of a waterflood as a precursor to CO<sub>2</sub> EOR will be compiled (e.g., fluid separation and handling facilities, pipelines, wells) to evaluate selected operating scenarios and to inform development strategies. This list will be compared to existing infrastructure at the Foreman Butte oil field to ascertain needs required to revitalize the selected field in anticipation of CO<sub>2</sub> EOR. A document (D3) will be created that describes infrastructure needs, opportunities, challenges, and priorities for operators and stakeholders looking to revitalize similar oil fields in North Dakota. D3 will be provided to NDIC at the end of Year 1.

**D4 – Surveillance and Data Integration – Priorities for Revitalization:** Operational (e.g., wellhead pressures and production rates) and reservoir (e.g., formation pressure and fluid saturation) surveillance play an important role in the prudent optimization and management of secondary production in preparation for CO<sub>2</sub> EOR. D2 and D3 results will be combined to generate a plan to collect and integrate reservoir and operational surveillance data as part of a project management strategy. Factors such as data acquisition and integration cost, environmental and operational impacts, etc., will be used to develop a document (D4) that discusses surveillance needs, opportunities, challenges, and priorities for operators

and stakeholders seeking to revitalize unitized analogue oil fields in North Dakota. D4 will be supplied to NDIC at the conclusion of Subtask 1.3.

**D5 – Technology Transfer and Progress Update:** A PowerPoint presentation (D5) outlining progress will be submitted to NDIC at the completion of Years 1 and 2. EEP Tundra and the EERC will also work with the Oil and Gas Research Council (OGRC) and the North Dakota Petroleum Council to identify and implement opportunities for EOR education in North Dakota.

**D6 – Final Report:** A final report (D6) will be submitted to NDIC at the end of Year 3 providing pertinent information regarding key technical challenges, flood design strategies, infrastructure priorities, data acquisition priorities, and sensitivity studies with regard to optimizing secondary production from analogous fields in preparation for CO<sub>2</sub> EOR. D6 will include a guidance document providing new information to enable operators, investors, regulators, and other stakeholders to make informed decisions regarding the revitalization of North Dakota’s vast conventional oil resources. Simulated production and performance response from the pertinent scenario analysis cases will be included.

**Anticipated Results:** This project will enable implementation of production practices not presently used in North Dakota to positively affect ultimate recovery from existing conventional oil pools. Results of this project may ultimately lead to additional projects, processes, ideas, and activities to implement oil exploration and production technologies to revitalize conventional oil fields in the state. Literature indicates that quality secondary recovery is often a harbinger of successful tertiary recovery. To support the design of quality secondary recovery operations, the proposed activities will generate results and guidance that provide North Dakota producers with a prototype for optimizing waterflood in unitized oil fields producing from the Madison Group (or other suitable production horizons) as a precursor to CO<sub>2</sub> EOR. Priorities for data collection and integration, operational monitoring, and facility upgrades will be generated. Combined with reservoir engineering that evaluates waterflood and CO<sub>2</sub> EOR operating scenarios pertinent to the selected field, the proposed activities will provide information to inform prudent strategies to revitalize analogue fields in North Dakota. The results will provide an improved

understanding of production potential for underexploited oil-producing formations. The infrastructure and facility priorities necessary for implementation of CO<sub>2</sub> EOR will be identified, including modifications to supervisory control and data acquisition (SCADA) systems and fluid-handling facilities.

**Facilities:** EEP Tundra has operational control, majority working interest, and access to the Foreman Butte oil field and associated infrastructure and data archives. EEP Tundra has decades of experience operating oil fields under primary production and waterflood and will manage all field operations.

A majority of the data collection and conditioning, reservoir characterization, modeling, laboratory analysis, facilities assessment, and product development work will be conducted at EERC facilities in Grand Forks, North Dakota. Modeling hardware at the EERC includes a high-performance computer cluster dedicated to advanced reservoir modeling and simulations. The EERC uses industry standard modeling and simulation software and has staff proficient in their use. EERC facilities include several laboratories and personnel with more than two decades of experience conducting standard and advanced core and fluid studies related to CO<sub>2</sub> EOR, including geomechanical, petrographic, geochemical, exposure and flow-through studies. The EERC has x-ray diffraction (XRD), x-ray fluorescence (XRF), and scanning electron microscopy (SEM) systems, as well as the ability to conduct wet-chemistry and advanced hydrocarbon and trace elemental analyses. The EERC's staff encompass geology, chemistry, physics, and engineering disciplines. The EERC has decades of experience related to CO<sub>2</sub> EOR and has led a broad range of research in support of North Dakota oil and gas research activities such as the Plains CO<sub>2</sub> Reduction (PCOR) Partnership Program and Bakken Production Optimization Program (BPOP).

**Resources:** A key resource for this project will be unique and full access to all components of the study field operated by EEP Tundra. EEP Tundra will provide access to the historical data archive for the study field, including reservoir characterization, production, and operational data not available in NDIC well files. The wells and facilities that comprise the study field asset will be available to the technical team to support the project activities as necessary. Information generated through new characterization, testing, well logging, and workover activities conducted in the selected field during the project will be

incorporated into the project tasks. EEP Tundra is committed to providing operational expertise and personnel to conduct fieldwork as necessary to facilitate the completion of proposed activities. Such work may include well testing, fluid and rock sampling, well logging, pressure monitoring, etc. Cores for these fields are stored at the North Dakota Geological Survey's Core and Sample Library.

EEP Tundra and the EERC will work closely with NDIC through project meetings and quarterly reporting to ensure project quality and timeliness. The educational contribution of the project will be fulfilled by conference presentations and publications, which may include presentations at the Williston Basin Petroleum Conference, public reporting (Deliverables 1–6), and engagement with the North Dakota Petroleum Council's outreach and education program.

**Techniques to Be Used, Their Availability and Capability:** Core-based studies will be conducted on core readily available at the North Dakota Geological Survey's Core and Sample Library in Grand Forks. Fluids studies will employ fluids collected from the study field. All core-based analytical activities will be conducted at or managed by the EERC and will use industry standard techniques. The EERC will determine minimum miscibility pressure (MMP) for oil from the study field with various CO<sub>2</sub> purities and reservoir conditions using the VIT (vanishing interfacial tension) technique (Hawthorne and others, 2016). Rock and fluid studies related to gas mobility, rock–fluid interactions, relative permeability, etc., will be conducted as needed, based on data requirements and priority.

Industry standard geologic characterization and reservoir engineering practices will be employed. Static and dynamic modeling activities will be conducted on computer hardware and software currently existing at the EERC. All personnel, equipment, space, and software to conduct the laboratory and modeling activities will be available through the duration of the project.

**Environmental and Economic Impacts While Project Is under Way:** The majority of the project will be conducted at the EERC. Fieldwork in the study field will be conducted following industry standard practices; thus, minimal environmental impact is expected. Over the 3-year period of performance, an

uptick in production, labor, and associated revenues is expected for the study field as EEP Tundra implements the results of the research and prepares the unit for waterflood as a precursor to CO<sub>2</sub> EOR.

**Ultimate Technological and Economic Impacts:** The proposed research will contribute to the development of North Dakota's oil resources, benefitting an area beyond the extent of current BPS production. The potential to revitalize conventional oil fields and increase ultimate recovery will bring new oil companies and industry investment to North Dakota, resulting in the growth of oil and gas jobs, wealth, and tax revenues. Recent studies indicate a minimum of 280 MMbbl to over 630 MMbbl of incremental oil recovery potential through the use of tertiary CO<sub>2</sub> EOR in 86 unitized conventional oil fields (NDLM, 2014). Assuming an average oil price of \$50/bbl and a 5% production tax rate, this incremental oil is worth between \$14 billion and \$30 billion, with \$0.7 billion to \$1.5 billion tax revenue.

**Why the Project Is Needed:** Although current productivity in the BPS is viable, production is susceptible to price volatility, and impacts from new regulation maximizing the productivity of conventional oil resources are essential to achieving Governor Burgum's challenge of 2 MMbpd of oil and for maintaining long-term economic stability and growth of the oil industry in North Dakota. The proposed activities are necessary to revitalize North Dakota's conventional oil fields through tertiary EOR. The results of the project will provide industry and the state of North Dakota with a foundation for developing a pathway to economically improve oil recovery from conventional fields.

North Dakota currently has no commercial CO<sub>2</sub> EOR projects in conventional fields. In addition, production is declining in conventional fields in part because of a lack of investment because of the focus on BPS. One of the primary challenges in increasing production via CO<sub>2</sub> EOR in conventional oil fields, particularly with respect to CO<sub>2</sub>, is attracting substantial capital investment in oil fields that are perceived as being in their final stages of productivity. This project will generate the new information and knowledge necessary to improve the probability of bringing to North Dakota the investment necessary to realize the state's fullest oil production potential. In total, 86 unitized legacy oil fields producing from the Madison Group (and other suitable producing horizons) have been identified as potential near-term CO<sub>2</sub>

EOR candidates, many of which are potential analogues for the selected field. The information generated by this project may be adapted to revitalize other fields that, if successfully applied, could increase production rates, more than double oil recoveries, prolong operational life, and are ESG-compliant project candidates. Revitalization using CO<sub>2</sub> EOR will require infill drilling and construction of new infrastructure and facilities. In short, revitalizing conventional oil fields will contribute to oil production and create new oil and gas jobs, wealth, and tax revenues for North Dakota for decades to come.

### **STANDARDS OF SUCCESS**

Success will be measured according to the achievement of project milestones and development of deliverables. The project's value to North Dakota is an understanding of the challenges associated with optimizing waterfloods prior to CO<sub>2</sub> EOR in conventional reservoirs. Results may influence industry practices and lead to improved oil recovery (~630 MMbbl incremental recovery potential). Commercial CO<sub>2</sub> EOR operations in conventional oil fields often last over 20 years. Successful application of CO<sub>2</sub> EOR could provide additional jobs and extend the life span of those jobs by another two decades. Commercial use of the project's results will rely not only on the nature of those results but also on the availability of commercial CO<sub>2</sub>. Although current CO<sub>2</sub> supplies in the Williston Basin are limited, projects that will bring millions of CO<sub>2</sub> from greenhouse gas capture projects and associated incentives to the EOR marketplace are in various stages of development within the next decade (e.g., Denbury Resources is planning to extend its Greencore CO<sub>2</sub> pipeline to North Dakota [U.S. News and World Report, 2017] and several industrial sources investing in carbon capture and storage [Red Trail Energy, Project Tundra, Summit Agricultural Group, Midwest AgEnergy, etc.]). Success of the project will also be based on the development of new data sets and technical documents for public dissemination. High-quality publications for an oil and gas audience will be made available to OGRP and other organizations.

### **BACKGROUND/QUALIFICATIONS**

Pat Nickodemus will be the project manager and principal investigator (PI) on the project. Other key personnel include Robert Mau of EEP Tundra and John Harju, John Hamling, Jim Sorensen, Wes Peck,

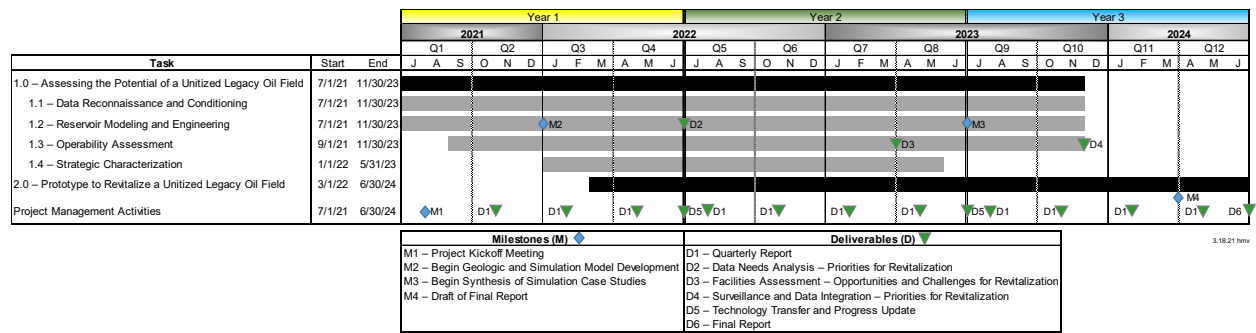
and Larry Pekot of the EERC. Resumes of key personnel are provided in Appendix C. EEP Tundra is an integrated team of operators, engineers, and investors working in all aspects of the oil and gas industry for the past 35 years. Members of the EEP Tundra team have a proven record of successfully applying secondary recovery techniques to multiple conventional oil fields in the Williston Basin.

The EERC, a high-tech, nonprofit branch of the University of North Dakota, is dedicated to moving applied research into the commercial marketplace. The EERC, practicing under a long-standing philosophy of collaboration and an interdisciplinary approach, brings a specialized technical group focusing on implementation of new approaches to the exploration, development, and production of oil and gas. Previous EERC projects have focused on EOR in conventional and unconventional oil fields in the Williston Basin. Since 2008, the EERC has managed and executed more than \$105 million of research funded by the U.S. Department of Energy in support of industry efforts to improve and optimize oil production from conventional and unconventional resources.

### MANAGEMENT

Deliverables and milestones will be incorporated into a contractual agreement to ensure the project is being carried out on schedule and in a manner that best ensures the objectives will be met. Progress reports will be prepared on a quarterly basis (due 30 days from the end of each calendar quarter) and will serve as a means of evaluating the project with respect to budget, schedule, and technical achievement. The evaluation points (i.e., deliverables and milestones) are identified in the following Gantt chart.

### TIMETABLE



## BUDGET

The estimated cost for the 3-year project is \$6,000,000. This proposal requests \$3,000,000 from NDIC through its OGRP, and EEP Tundra commits to providing at least \$3,000,000 in cofunding, on top of the substantial unenumerated value of free and ready access to wells, data, and facilities, as shown in the table below. Of EEP Tundra's contribution, at least \$1,500,000 will be in the form of engineering and field services (e.g., reservoir testing, well workovers, collection of fluid samples), and \$1,500,000 will contribute toward the EERC's total subcontract of \$4,500,000.

Project Associated Expense	NDIC Share	EEP Tundra Share (cash)	Total
Engineering and Field Services	\$ -	\$ 1,500,000	\$ 1,500,000
Subcontractor – EERC	\$ 3,000,000	\$ 1,500,000	\$ 4,500,000
<b>Total Project Cost</b>	<b>\$ 3,000,000</b>	<b>\$ 3,000,000</b>	<b>\$ 6,000,000</b>

The EERC will provide technical (analytical, laboratory, and reservoir engineering) and managerial support for this effort. Appendix A contains a letter of commitment from the EERC and a budget. If the requested amount of funding is not available, the stated goals and objectives will be unattainable because project success is directly tied to integration of the proposed technical activities.

## CONFIDENTIAL INFORMATION

Although there is no confidential information included in the proposal, there is a reasonable expectation that confidential information will be involved in, or created during, the execution of the project. In such cases, confidential information will be withheld from public disclosure. However, the intent of the project is to make as much information publicly available as possible while protecting the interests of EEP Tundra.

## PATENTS/RIGHTS TO TECHNICAL DATA

Patents or rights do not apply to this proposal.

## STATUS OF ONGOING PROJECTS (IF ANY)

EEP Tundra has not previously been awarded OGRP funding.

**APPENDIX A**  
**EERC LETTER OF SUPPORT**



March 25, 2021

Mr. Robert Mau  
President, Chairman/Operator  
Eagle Energy Partners Tundra, LLC  
2501 6th Street Southeast, Suite B  
Minot, ND 58701

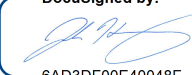
Dear Mr. Mau:

Subject: EERC Proposal No. 2018-0066 Entitled “Revitalizing Conventional Oil Fields in North Dakota”

The Energy & Environmental Research Center (EERC) is excited to proceed with the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP) project entitled “**Unitized Legacy Oil Fields: Prototypes for Revitalizing Conventional Oil Fields in North Dakota**” in collaboration with Eagle Energy Partners Tundra, LLC.

The EERC will work closely with Eagle Energy Partners Tundra to investigate CO<sub>2</sub> enhanced oil recovery (EOR) potential of the Foreman Butte oil field in McKenzie County, North Dakota, which is producing from the Ratcliff Interval of the Madison Formation as a prototype for the revitalization of conventional oil fields in North Dakota. As enumerated in the subject proposal and the amended application package provided to OGRP by Eagle Energy Partners Tundra, the EERC remains committed to accomplishing the objectives of the project. We look forward to collaborating with Eagle Energy Partners Tundra, LLC, and NDIC on this exciting revitalization effort. If you have any questions, please contact me by phone at (701) 777-5472 or by e-mail at [jhamling@undeerc.org](mailto:jhamling@undeerc.org).

Best regards,

DocuSigned by:  
  
6AD3DF00E40048F...

John A. Hamling

Assistant Director for Integrated Projects

JAH/rlo



February 15, 2018

Mr. Robert Mau  
President, Chairman/Operator  
Eagle Energy Partners I, LLC  
2501 6th Street Southeast, Suite B  
Minot, ND 58701

Dear Mr. Mau:

Subject: EERC Proposal No. 2018-0066 Entitled “Revitalizing Conventional Oil Fields in North Dakota”

The Energy & Environmental Research Center (EERC) is excited to support Eagle Energy Partners I, LLC, in its proposal to the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP) entitled “**Fryburg and Medora Unitized Fields: Prototypes for Revitalizing Conventional Oil Fields in North Dakota.**” The proposed scope of work directly aligns with the NDIC OGRP mission to *promote the growth of the oil and gas industry through research and education* and the EERC’s vision to *lead the world in developing solutions to energy and environmental challenges through innovative science and engineering.*

As part of the proposed research effort, the EERC will work closely with Eagle Energy Partners I, LLC, to investigate CO<sub>2</sub> enhanced oil recovery (EOR) potential and develop pathways for the Heath (Tyler) and Madison pools of the unitized Medora and Fryburg Fields as prototypes for the revitalization of conventional oil fields in North Dakota. Specific activities to be conducted by the EERC will include 1) reconnaissance and conditioning of historical data from both fields; 2) geologic assessment and reservoir engineering, including generation of geomodels and reservoir simulations to define and evaluate prudent revitalization strategies and prioritize data needs; 3) strategic characterization, including new reservoir testing and laboratory-based rock and fluid studies to improve simulation performance; 4) an operability assessment and priorities for infrastructure and monitoring implementation; 5) recommendations for EOR schemes and modifications to infrastructure, facilities, and operational parameters necessary for optimizing waterflood operations in preparation for future CO<sub>2</sub> EOR; and 6) synthesis of project results into products that can be used to guide stakeholders looking to revitalize conventional reservoirs in North Dakota.

Execution of the proposed research will contribute to the development of North Dakota’s endowment of oil, benefiting areas beyond the extent of current Bakken petroleum system production. Although 95% of North Dakota’s production comes from the unconventional Bakken and Three Forks plays, billions of barrels of oil are still in place within the state’s conventional oil fields. Those fields, many of which were established decades ago, are prime candidates for revitalization. The application of modern techniques for characterization, modeling, development, and management of established fields in the Tyler and Madison Formations will provide broadly applicable information that can improve resource estimates and inform efficient recovery strategies throughout the Williston Basin. The products from proposed research will empower producers with information that can be applied to better assess recovery

Mr. Mau/2  
February 15, 2018

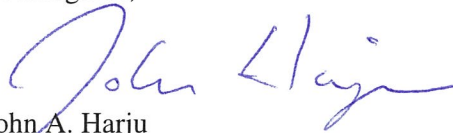
potential; inform prudent operational strategies, including optimization of secondary recovery to prepare for tertiary EOR; and contribute to the development of tertiary CO<sub>2</sub> oil recovery projects throughout the Williston Basin.

The revitalization of conventional resources such as those in the Madison and Tyler Formations will directly contribute to Governor Burgum's North Dakota production challenge of exceeding 2 million barrels of oil per day. The project may also contribute to potential proliferation of CO<sub>2</sub> EOR in North Dakota, providing synergistic benefits to potential CO<sub>2</sub> providers and leading to a cleaner energy future for North Dakota.

As a premier research entity with experience managing OGRP projects, the EERC is committed to managing the proposed project on behalf of Eagle Energy Partners I, LLC. We are prepared to leverage our experience and provide the necessary technical resources to ensure the successful execution and fulfillment of reporting requirements for the research activities. Should the project be awarded, the EERC will perform these activities for the estimated cost of \$4,500,000 over 36 months. Payment terms will be determined during contract negotiations.

We believe that the potential long-lasting economic and technological benefits of the proposed research far exceed the requested investment from NDIC OGRP and Eagle Energy Partners I, LLC. We look forward to collaborating with Eagle Energy Partners I, LLC, and NDIC on this exciting revitalization effort. If you have any questions, please contact me by phone at (701) 777-5157 or by e-mail at [jharu@undeerc.org](mailto:jharu@undeerc.org).

Best regards,



John A. Harju  
Vice President for Strategic Partnerships

Approved by:



Thomas A. Erickson, Director  
Energy & Environmental Research Center

JAH/kal

**BUDGET**

EERC Proposal No. 2018-0066  
 Revitalizing Conventional Oil Fields in North Dakota

<b>Project Associated Expense</b>	<b>NDIC Share (Cash)</b>	<b>EEPT Share (Cash)</b>	<b>Total Project</b>
Labor	\$ 1,747,601	\$ 927,575	\$ 2,675,176
Travel	\$ 20,600	\$ 5,286	\$ 25,886
Supplies	\$ 10,827	\$ 3,173	\$ 14,000
Communications	\$ 352	\$ 248	\$ 600
Printing & Duplicating	\$ 2,021	\$ 385	\$ 2,406
Food	\$ 2,323	\$ -	\$ 2,323
Laboratory Fees & Services			\$ -
GC/MS Lab	\$ 150,000	\$ -	\$ 150,000
Graphics Service	\$ 9,632	\$ 832	\$ 10,464
Outside Lab	\$ 50,000	\$ -	\$ 50,000
Facilities & Admin. Rate	\$ 1,006,644	\$ 562,501	\$ 1,569,145
<b>Total Project Cost</b>	<b>\$ 3,000,000</b>	<b>\$ 1,500,000</b>	<b>\$ 4,500,000</b>

## **APPENDIX B**

# **RELEVANT EERC LABORATORY CAPABILITIES**

## RELEVANT EERC LABORATORY CAPABILITIES

### Applied Geology Laboratory

- Full preparation laboratory, including slab saw, core drills, micronizing mill, and thin-section mill
- Petrographic microscopes using plane- and cross-polarized transmitted light
- Nanovea PS 50 optical profilometer
- Forney 20+-ton universal compression frame
- Trautwein-Geotac flexible wall permeameter
- Hoek-style triaxial and core-flood cells
- Teledyne Isco high-pressure fluid pumps
- Gas porosimeter/pycnometer
- Terraplug RS125 supergamma spectrometer
- Dead weight consolidation frames
- Thermal dilatometer
- Ion chromatograph
- Distillation, saturation, and chemistry equipment

### Natural Materials Analytical Research Laboratory

- 4200-square-foot laboratory facility
- JEOL 5800 scanning electron microscope with NORAN instruments energy-dispersive spectrometer (EDS) detector system, GW Electronics enhanced backscatter detector, and NORAN instruments microanalysis system
- JEOL 5800 LV with Princeton Gamma-Tech Spirit Instruments EDS and microanalysis system and a HKL Technology electron backscatter diffraction system.
- QEMSCAN<sup>®</sup>
- Rigaku ZSK Primus II x-ray fluorescence system
- Bruker AXS D8 advanced x-ray diffraction system

### Analytical Research Laboratory

- 4200-square-foot, fully equipped, exceedingly clean laboratory with seven fume hoods
- VG PQ ExCell inductively coupled plasma–mass spectrometer (ICP–MS) with collision cell technology
- PS Analytical Millennium Merlin cold-vapor atomic fluorescence spectrometer (CVAFS)
- PS Analytical Millennium Excalibur hydride generation atomic fluorescence spectrometer (HGAFS)
- Varian Spectra AA-880Z graphite furnace atomic absorption spectrometer (GFAAS)
- Mitsubishi TOX-100 chlorine analyzer with oxidative hydrolysis microcoulometry
- Perkin Elmer Optima 2100 ICP–AES
- Dionex ISC3000 ion chromatograph (IC) with conductivity detection
- Dionex 2020i IC with UV–VIS, conductivity, and electrochemical detection
- CEM MDS 2100 microwave with temperature and pressure control
- Pyrohydrolysis/ion-specific electrode for fluorine analysis of fossil fuels

## **APPENDIX C**

### **RESUMES OF KEY PERSONNEL**

**PAT NICKODEMUS**

Principal, Operations & Investor Relations  
Eagle Energy Partners I, LLC (EEP Tundra)  
2501 6th Street Southeast, Suite B, Minot, North Dakota 58701  
Phone: 970.556.0814, E-Mail: pat@eagleenergypartnersllc.com

***Professional Summary***

Mr. Pat Nickodemus, Principal, Operations & Investor Relations at EEP Tundra, has 20+ years of C-level risk management and operations experience, specializing in insurance, safety, and risk management solutions for both upstream and midstream oil and gas companies. He holds a B.S. degree in Finance and Marketing from Chadron State College, Chadron, Nebraska.

- 20+ years C-level risk management and operations experience, specializing in insurance, safety and risk management solutions for both upstream and midstream oil and gas companies
- Assisted in developing insurance coverage forms for oil and gas operators and contractors
- Began working in ND oil and gas insurance in the 1990's
- Implemented and improved safety standards for oil and gas focused clients
- Developed largest Oil and Gas Insurance association in Colorado
- Chadron State College, B.S. in Finance and Marketing
- Member North Dakota Petroleum Council

**ROBERT MAU**

Chair, Principal, and Operator  
Eagle Energy Partners I, LLC (EEP Tundra)  
2501 6th Street Southeast, Suite B, Minot, North Dakota 58701  
Phone: 701.837.4780, E-Mail: eagleop@yahoo.com

***Professional Summary***

Mr. Mau, Chair, Principal, and Operator at EEP Tundra, has 35+ years of experience as an operator and in all aspects of the upstream and midstream oil and gas business. He currently oversees all investments made by EEP Tundra and is Chair of the Investment Committee. Under his leadership, hundreds of wells have been drilled, produced, and operated since 1991. The company has employed secondary recovery techniques since 2002, with an average of >5 times estimated production increases achieved and, in some cases, as high as 11 times.

Mr. Mau founded Eagle Operating Inc. in 1991, where he served as President. He founded Wolverine Drilling Co. 1996, the largest North Dakota-based drilling company at time of acquisition in 2004. He founded Eagle Well Service in the early 2000s, the largest North Dakota-based well service contractor (16 rigs) at time of acquisition in 2012. He was also the founder of MW Industries, a drilling rig-manufacturing company located in Kenmare, North Dakota.

Mr. Mau is a Former Chair of the North Dakota Petroleum Council and currently serves on its Board of Directors and Executive Committee since 1999. He was appointed by North Dakota Governor John Hoeven to serve on the Interstate Oil and Gas Compact Commission and the Oil and Gas Research Council. In 2007, he received the Pioneer Award from the Energy & Environmental Research Center's Plains CO<sub>2</sub> Reduction Partnership. In 2013, he was inducted into the North Dakota Petroleum Council Hall of Fame.



**JOHN A. HARJU**

Vice President for Strategic Partnerships

Energy & Environmental Research Center (EERC), University of North Dakota (UND)

15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA

701.777.5157 (phone), 701.777.5181 (fax), jharju@undeerc.org

***Principal Areas of Expertise***

Mr. Harju's principal areas of interest and expertise include carbon sequestration, enhanced oil recovery, unconventional oil and gas development, waste management, geochemistry, technology development, hydrology, and analytical chemistry, especially as applied to the upstream oil and gas industry.

***Qualifications***

B.S., Geology, University of North Dakota, 1986.

Postgraduate course work in Management, Economics, Marketing, Education, Climatology, Weathering and Soils, Geochemistry, Geochemical Modeling, Hydrogeochemistry, Hydrogeology, Contaminant Hydrogeology, Advanced Physical Hydrogeology, and Geostatistics.

***Professional Experience***

**2002–Present:** EERC, UND, Grand Forks, North Dakota.

July 2015–Present: Vice President for Strategic Partnerships. Mr. Harju leads efforts to build and grow dynamic working relationships with industry, government, and research entities globally in support of the EERC's mission to provide practical, pioneering solutions to the world's energy and environmental challenges. He represents the EERC regionally, nationally, and internationally in advancing its strategic energy and environmental initiatives focused on conventional and unconventional oil and gas development; zero-emission coal utilization; CO<sub>2</sub> capture and sequestration; energy and water sustainability; hydrogen and fuel cells; advanced air emission control technologies, emphasizing SO<sub>x</sub>, NO<sub>x</sub>, air toxics, fine particulate, and mercury control; renewable energy; wind energy; water management; flood prevention; global climate change mitigation; waste utilization; energy efficiency; and contaminant cleanup.

2003–June 2015: Associate Director for Research. Mr. Harju led the activities of a team of scientists and engineers, building industry–government–academic teams to carry out research, development, demonstration, and commercialization of energy and environmental technologies.

2002–2003: Senior Research Advisor. Mr. Harju's responsibilities included development, marketing, management, and dissemination of market-oriented research; development of programs focused on the environmental and health effects of power and natural resource production, contaminant cleanup, water management, and analytical techniques; publication and presentation of results; client interactions; and advisor to internal staff.

**2017–Present:** Adjunct Lecturer, Department of Petroleum Engineering, UND.

**1999–2002:** Vice President, Crystal Solutions, LLC, Laramie, Wyoming. Mr. Harju's firm was involved in commercial E&P produced water management, regulatory permitting and compliance, and environmental impact monitoring and analysis.

**1997–2002:** Gas Research Institute (GRI) (now Gas Technology Institute [GTI]), Chicago, Illinois.  
2000–2002: Principal Scientist, Produced Water Management. Mr. Harju’s responsibilities included development and deployment of produced water management technologies and methodologies for cost-effective and environmentally responsible management of oil and gas produced water.

1998–2000: Program Team Leader, Soil, Water, and Waste. Mr. Harju’s responsibilities included project and program management related to the development of environmental technologies and informational products related to the North American oil and gas industry; formulation of RFPs, proposal review, and contract formulation; technology transfer activities; and staff and contractor supervision. Mr. Harju served as Manager of the Environmentally Acceptable Endpoints project, a multiyear programmatic effort focused on a rigorous determination of appropriate cleanup levels for hydrocarbons and other energy-derived contaminants in soils. He also led GRI/GTI involvement with numerous industry environmental consortia and organizations, including PERF, SPE, AGA, IPEC, and API.

1997–1998: Principal Technology Manager, Soil and Water Quality.

1997: Associate Technology Manager, Soil and Water Quality.

**1988–1996:** EERC, UND, Grand Forks, North Dakota.

1994–1996: Senior Research Manager, Oil and Gas Group. Mr. Harju’s responsibilities included the following:

- Program Manager for program to assess the environmental transport and fate of oil- and gas-derived contaminants, focused on mercury and sweetening and dehydration processes.
- Project Manager for field demonstration of innovative produced water treatment technology using freeze crystallization and evaporation at oil and gas industry site.
- Program Manager for environmental transport and fate assessment of MEA and its degradation compounds at Canadian sour gas-processing site.
- Program Manager for demonstration of unique design for oil and gas surface impoundments.
- Director, National Mine Land Reclamation Center for Western Region.
- Co-Principal Investigator on project exploring feasibility of underground coal gasification in southern Thailand.
- Consultant to International Atomic Energy Agency for program entitled “Solid Wastes and Disposal Methods Associated with Electricity Generation Fuel Chains.”

1994: Research Manager.

1990–1994: Hydrogeologist.

1989–1990: Research Specialist.

1988–1989: Laboratory Technician.

### ***Professional Memberships***

U.S. Department of Energy Unconventional Resources Technology Advisory Committee  
Interstate Oil and Gas Compact Commission Energy Resources, Research, and Technology Committee  
(former Chair) and Carbon Capture and Geological Storage Task Force  
National Petroleum Council  
Rocky Mountain Association of Geologists

### ***Publications and Presentations***

Has authored and coauthored more than 100 professional publications.



**JOHN A. HAMLING**

Principal Engineer, Oilfield Operations Group Lead  
Energy & Environmental Research Center (EERC), University of North Dakota (UND)  
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA  
701.777.5472 (phone), 701.777.5181 (fax), jhamling@undeerc.org

***Principal Areas of Expertise***

Mr. Hamling has over 10 years of combined experience in unconventional oil and gas development, enhanced oil recovery (EOR), and carbon capture, utilization, and storage (CCUS). He is a Principal Engineer at the EERC, where he integrates science and operations to catalyze pioneering solutions for geologic CO<sub>2</sub> utilization and the exploration, development, and production of oil and gas in unconventional plays.

Mr. Hamling's areas of expertise include development, implementation, and oversight of surface, near-surface, deep subsurface, and reservoir characterization and surveillance programs for geologic CO<sub>2</sub> storage and EOR. His experience includes well-logging principals and applications; well drilling, well completions; wellbore integrity; risk assessment; logistics; well stimulation and enhanced recovery in tight oil plays; and health, safety, and environmental (HSE) programs.

Mr. Hamling has served as project manager (PM), principal investigator (PI), and task lead for several multiyear, multimillion-dollar research and demonstration projects. He leads the data analytics, operations, and reservoir surveillance groups at the EERC as well as several adaptive multidisciplinary project teams. These activities encompass both contract research as well as several strategic partnership programs between the state of North Dakota, the U.S. Department of Energy (DOE), and private industry designed to propel the development and implementation of approaches that benefit practical energy development. In addition, he is an Adjunct Lecturer in the Department of Petroleum Engineering at UND.

***Qualifications***

B.S., Mechanical Engineering, University of North Dakota, 2007.  
Associate of Science, Associate of Arts, Williston State College, 2004.  
Certified Engineer in Training (EIT)

***Professional Experience***

**2012–Present:** Principal Engineer, Oilfield Operations Group Lead, EERC, UND. Mr. Hamling currently serves as PM, PI, and task lead for several multiyear, multimillion-dollar projects, where he leads a multidisciplinary team of scientists and engineers working to develop and implement monitoring, verification, and accounting (MVA) concepts for large-scale (>1 million tons per year) CO<sub>2</sub> storage and EOR operations. He also works with a multidisciplinary team in the development, design, and implementation of new approaches that benefit the economic exploration, development, and production of oil and gas.

**2017–Present:** Adjunct Lecturer, Department of Petroleum Engineering, UND.

**2011–2012:** Research Manager, EERC, UND. Mr. Hamling's responsibilities included managing characterization and monitoring research activities and operations for large-scale (>1 million tons per year) combined EOR and CO<sub>2</sub> storage projects for the Plains CO<sub>2</sub> Reduction (PCOR) Partnership. He also

led various research activities related to oil and gas production, infrastructure, and development from unconventional reservoirs.

**2009–2011:** Research Engineer, EERC, UND. Mr. Hamling’s focus was on the design and implementation of new approaches that benefit the exploration, development, and production of oil and gas and with the PCOR Partnership, where he evaluated the potential for CO<sub>2</sub> storage in geologic formations. Specific responsibilities included field operations design, deployment, and interpretation relating to oilfield technologies applicable to the CO<sub>2</sub> capture and storage (CCS) industry; laboratory functions relating to the Applied Geology Laboratory (AGL); data analysis; regulatory compliance; and communication of operations between service providers, management teams, industry partners, and governmental organizations. Additional responsibilities included investigation and/or demonstration of techniques and/or technologies that can enhance oil and gas production or economically benefit the oil and gas industry while reducing the environmental footprint of drilling and production operations.

**2007–2009:** Reservoir Evaluation Engineer; HSE Representative; and Loss Prevention Team Leader, Reservoir Evaluation segment, Schlumberger Limited. Mr. Hamling was responsible for providing tailored geophysical solutions for specific and unique oilfield applications, executing basic and advanced reservoir evaluations utilizing real-time wellbore measurement technologies, reservoir pressure and fluid sampling, and interpretation of reservoir measurement data. In this role, Mr. Hamling designed and oversaw all aspects of openhole and cased-hole logging operations for over 300 wells in both conventional and unconventional oil and gas plays. He also served as an HSE officer, loss prevention team lead, and explosives and radiation safety officer for wellsite activities.

**2004–2007:** Student Research Scientist/Engineer, EERC, UND. Mr. Hamling was responsible for conducting research related to the development of new methods to join high-temperature, creep-resistant alloys and advanced processing and manufacture techniques for silicon carbide ceramic composites; materials testing in accordance with ASME (American Society of Mechanical Engineers), ASTM International, and ISO (International Organization for Standardization) standards; analyzing scanning electron microscopy micrographs; designing and fabricating composite micrometeorite shielding; and literature and patent review.

### ***Professional Activities***

Society of Petroleum Engineers International Williston Basin Section – have continuously served as a section officer and board member since 2012. Positions include Acting Chairperson, Vice-Chairperson, and Communications Chairperson.

Served as PCOR Partnership representative on the writing committee for two U.S. Department of Energy Regional Carbon Sequestration Partnership (RCSP) Program BPMs entitled *Best Practices for Monitoring, Verification, and Accounting of CO<sub>2</sub> Stored in Deep Geologic Formations – Version 3* and *Best Practices for Operating Carbon Storage Projects*.

### ***Publications and Presentations***

Has authored and coauthored numerous technical publications.



**JAMES A. SORENSEN**

Principal Geologist

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 (phone), 701.777.5181 (fax), jsorensen@undeerc.org

***Principal Areas of Expertise***

Mr. Sorensen's principal areas of interest and expertise include tight oil resource assessment and development, carbon dioxide utilization and storage in geologic formations, and environmental issues associated with the oil and gas industry.

***Education***

B.S., Geology, University of North Dakota, 1991.

Postgraduate course work in Geology and Hydrogeology, 1993–1995.

***Professional Experience***

**1999–Present:** Principal Geologist, EERC, UND. Mr. Sorensen currently serves as manager and co-principal investigator for several research programs, including the Plains CO<sub>2</sub> Reduction (PCOR) Partnership, a multiyear program focused on developing strategies for reducing carbon dioxide emissions in nine states and four Canadian provinces. He has also conducted projects to develop an improved understanding of the Bakken petroleum system, including efforts to examine the potential to use carbon dioxide for enhanced oil recovery in the Bakken. Responsibilities include supervision of research personnel, preparing and executing work plans, budget preparation and management, writing technical reports and papers, presentation of work plans and results at conferences and client meetings, and proposal writing and presentation.

**1997–1999:** Program Manager, EERC, UND. Mr. Sorensen managed projects on topics that included produced water management, environmental fate of natural gas-processing chemicals, coalbed methane, and gas methane hydrates.

**1993–1997:** Geologist, EERC, UND. Mr. Sorensen conducted a variety of field-based hydrogeologic investigations throughout the United States and Canada. Activities were primarily focused on the subsurface mobility of constituents associated with natural gas production sites.

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

***Professional Memberships***

Society of Petroleum Engineers

***Publications and Presentations***

Has coauthored nearly 200 publications.



**WESLEY D. PECK**

Principal Geologist, Geoscience Group Lead  
Energy & Environmental Research Center (EERC), University of North Dakota (UND)  
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA  
701.777.5195 (phone), 701.777.5181 (fax), wpeck@undeerc.org

***Principal Areas of Expertise***

Mr. Peck's principal areas of interest and expertise include geographic information systems (GIS), cartography, information graphics, geology, and digital asset management. Mr. Peck currently oversees GIS activities for the Plains CO<sub>2</sub> Reduction (PCOR) Partnership. He is also the task leader for two regional characterization efforts within the PCOR Partnership.

***Qualifications***

M.S., Geology, University of North Dakota, 1992. Thesis: The Stratigraphy and Sedimentology of the Sentinel Butte Formation (Paleocene) in South-Central Williams County, North Dakota.  
B.S., Earth Science, North Dakota State University, 1987.

***Professional Experience***

**2015–Present:** Principal Geologist, Geoscience Group Lead, EERC, UND. Mr. Peck leads a staff of geoscientists involved in subsurface resource development with an emphasis on the Williston and Powder River Basins. He also serves as task lead and principal investigator of the regional geologic characterization component of the Plains CO<sub>2</sub> Reduction Partnership (PCOR) Partnership Program, which focuses on carbon dioxide storage in central North America.

**2011–2015:** Research Manager, EERC, UND. Mr. Peck's responsibilities include overseeing a staff of geologists and GIS specialists involved with oil and gas research activities in the Williston Basin as well as regional geologic characterization activities associated with the PCOR Partnership.

**1991–2011:** Research Scientist, EERC, UND. Mr. Peck's responsibilities included overseeing major GIS activities at the EERC, serving as task leader for the regional characterization component of the PCOR Partnership, as well as report and proposal writing.

**1989–1991:** Graduate Research Assistant, EERC, UND. Mr. Peck's responsibilities included acquisition and management of geologic data related to Cretaceous and Tertiary geology of the Williston Basin. Mr. Peck also assisted in the collection of Cretaceous and Tertiary fossils and stratigraphic information in western North Dakota and eastern Montana.

***Publications and Presentations***

Has authored and coauthored several professional publications.



**LAWRENCE J. PEKOT**

Principal Engineer, Reservoir Engineering Group Lead  
Energy & Environmental Research Center (EERC), University of North Dakota (UND)  
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA  
701.777.5376 (phone), 701.777.5181 (fax), lpekot@undeerc.org

***Principal Areas of Expertise***

Mr. Pekot's principal areas of interest and expertise include unconventional reservoir engineering, including CO<sub>2</sub> storage and enhanced oil recovery (EOR), coalbed methane (CBM), enhanced coalbed methane (ECBM), shale gas, natural gas storage, and hydraulic fracturing; integrated project management; field studies; and reserve evaluations.

***Qualifications***

B.S., Civil Engineering, Pennsylvania State University, 1978.  
B.S., Geological Science, Pennsylvania State University, 1978.

***Professional Experience***

**September 2015–Present:** Principal Engineer, Reservoir Engineering Group Lead, EERC, UND. Mr. Pekot's responsibilities include:

- Leading reservoir engineering evaluations for CO<sub>2</sub> EOR, CO<sub>2</sub> storage, and unconventional hydrocarbon recovery projects.
- Leading a group of reservoir engineers on multiphase flow, geomechanical, and thermal simulations.

**2013–2015:** International Project Manager, Schlumberger Carbon Services, Denver, Colorado. Mr. Pekot's responsibilities included:

- Management of CO<sub>2</sub> evaluation projects outside of the United States, Australia, and Canada.
- Supervision of site selection studies, simulation, appraisal planning, risk analysis, injection testing and monitoring technologies, regulatory compliance, cost estimation, and reporting.
- Supervision and mentoring of junior staff.

**2008–2013:** Technical Manager for Europe/Africa, Schlumberger Carbon Services, Paris, France. Mr. Pekot's responsibilities included:

- Technical oversight of carbon storage evaluation projects and opportunities in Europe and Africa, including work in the United Kingdom, Ireland, Spain, Italy, Poland, Romania, Bulgaria, Libya, South Africa, and Australia.
- Coordination of projects and resources between Schlumberger's Consulting and Carbon Services businesses.
- Strategic, technical, and business development assistance for unconventional reservoir problems, including natural gas storage, geothermal, CBM, and EOR.
- Management of corporate special projects and resource evaluations.
- Project peer reviews for other business units.
- Introduction of corporate project management procedures to Carbon Services.
- Junior staff mentoring and introduction to the corporate technical advancement system.

**2004–2007:** Principal Consultant, Schlumberger Data and Consulting Services, Pittsburgh, Pennsylvania. Mr. Pekot's responsibilities included:

- Engineering studies for tight gas, gas storage, shale, and CBM properties in the United States and Canada.
- Reserve reporting evaluations for conventional, CBM, and CO<sub>2</sub> flood properties.
- EOR CO<sub>2</sub> flood evaluations of Michigan Basin pinnacle reef reservoirs.
- Saline formation test site modeling for CO<sub>2</sub> storage in Ohio and Texas; one done for Schlumberger R&D.
- Initial evaluation and carbon sequestration site prescreening for carbon storage for the New York Clean Coal Power Initiative.
- Two CO<sub>2</sub> sequestration site screening evaluations for U.S. electric utility clients.
- A Pacific Basin overview study of CO<sub>2</sub> EOR and ECBM potential for a Japanese client.

**1995–2003:** Vice President, Advanced Resources International, Inc., Washington, D.C. Mr. Pekot's responsibilities included:

- Development, maintenance, and marketing of the firm's technical software programs, COMET for reservoir simulation and METEOR for analytic type curve evaluations.
- Serving as a reservoir engineering advisor for the U.S. Federal Energy Regulatory Commission.
- Performing or supervising well testing and numerical simulation evaluations of numerous gas, oil, gas storage, CBM, ECBM, and other unconventional reservoirs, including projects in Australia, Canada, China, Czech Republic, India, Poland, South Africa, and the United States.
- Exploration, appraisal, and development planning.
- ECBM simulation.
- Evaluation of geologic storage options for greenhouse gas sequestration potential.
- Shale gas well performance evaluation.
- Estimated reserves for merger and acquisition economic evaluations.
- Field demonstration of advanced simulation technologies for gas storage wells.
- Well testing and evaluation methodologies for gas storage remediation candidate selection.
- Supervision of the reservoir simulation and design of the development plan for the first gas storage reservoir in the People's Republic of China.

**1991–1995:** Principal Consultant, Scandpower A/S (now known as SPT Group of Schlumberger), Oslo, Norway. Mr. Pekot's responsibilities included:

- Administrative supervision of a team of four engineering consultants.
- Project management.
- Technical assistance to junior staff.
- Software marketing and technical support.
- Consulting for
  - PEMEX (Mexico).
  - Norsk Hydro, where he used state-of-the-art engineering techniques and simulation software (ECLIPSE) to help optimize the \$2 billion oil development plan for the Troll Field in the North Sea, edited the reservoir engineering proposal for a \$150 million field expansion, and prepared and delivered numerous presentations to license holders and government authorities.
  - Saga Petroleum, where he developed an engineering and geologic database for the unitized Snorre Field to be used in field ownership redetermination and conducted a reservoir simulation study to determine optimum recovery techniques for the Gullfaks South reservoir.

**1978–1991:** Senior Petroleum Engineer, Phillips Petroleum Company, Stavanger, Norway, and Houston, Texas. Mr. Pekot's responsibilities included the following:

- Senior Joint Venture Engineer for Gulf of Mexico properties (3 years), including profit and loss accountability for a \$20 million capital and expense budget; economic evaluation for \$60 million development of a new gas field; technical and economic evaluations for rehabilitation of a large, old oil field, where production doubled and reserves increased 50%; evaluation of deep-water exploration leases; technical and economic analysis for drilling, well workovers, process equipment upgrades, platform construction, and rehabilitation, writing project justifications and obtaining approvals; and Reserves evaluations.
- Senior Engineer (4 years), including supervision of a team of engineers for numerical simulation of North Sea oil and gas fields; setting group objectives and scheduling and delegating assignments; junior staff performance evaluation and career counseling; drilling and workover proposal justifications; economic analysis; reservoir management plan maintenance and updates; evaluation of oil and gas reserves under depletion and various gas and water injection development proposals; and temporary section leader, supervising ten engineers.
- Associate Production Geologist (2 years), including wellsite geology; correlating geological and geophysical data and creating maps and cross sections, geological field study for the development of the Tommeliten gas fields, coauthoring and editing the geologic field study for the \$1 billion Ekofisk Field waterflood project, and serving on the project team that developed a North Sea geological database.
- Staff Reservoir Engineer (3 years), including wellsite testing and analysis of new gas production wells, well test analysis and selection of new drilling locations, evaluation of field production problems, technical report writing, corrective action recommendations, and unitized field operations; found new reserves located in formations previously considered uneconomical.
- General land-based production (1 year), including EOR projects, drilling, and workover operations, and land surveying and piping design.

***Professional Affiliations***

Member, Society of Petroleum Engineers Distinguished Lecture Review Committee, 2006–2011  
Technical Reviewer, *International Journal of Coal Geology and International Journal of Greenhouse Gas Control*  
Adjunct lecturer, University of North Dakota Dept. of Petroleum Engineering

***Publications and Presentations***

Has authored or coauthored numerous publications.

## **APPENDIX D**

## **REFERENCES**

## REFERENCES

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