EERC
Energy & Environmental Research Center
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May 7, 2019

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

Dear Ms. Fine:

Subject: EERC Proposal No. 2019-0168 Entitled "Underground Storage of Produced Natural Gas – Conceptual Evaluation and Pilot Project(s) (HB 1014)"

The Energy & Environmental Research Center (EERC) is pleased to submit this proposal per the directive set forth in Section 25 of HB 1014 of the Sixty-Sixth Legislative Assembly of North Dakota, as signed into law by Governor Burgum.

Enclosed please find an original and one copy of the subject proposal along with a check for $100. The EERC, a research organization within the University of North Dakota, an institution of higher education within the state of North Dakota, is not a taxable entity; therefore, it has no tax liability.

This transmittal letter represents a binding commitment by the EERC to complete the project described in this proposal. If you have any questions, please contact me by telephone at (701) 777-5157, by fax at (701) 777-5181, or by e-mail at jharju@undeerc.org.

Sincerely,

John A. Harju
Vice President for Strategic Partnerships

Tom Erickson, CEO
Energy & Environmental Research Center

JAH/rlo

Enclosures

c/enc: Lynn Helms, North Dakota Industrial Commission
Brent Brannan, Oil and Gas Research Council

Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Project Title: Underground Storage of Produced Natural Gas – Conceptual Evaluation and Pilot Project(s) (HB 1014)

Applicant: Energy & Environmental Research Center

Principal Investigator: Bethany A. Kurz

Date of Application: May 7, 2019

Amount of Request: $6,000,000

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

Duration of Project: 25 months

Point of Contact (POC): Bethany A. Kurz

POC Telephone: (701) 777-5050

POC E-Mail Address: bkurz@undeerc.org

POC Address:

15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

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ABSTRACT

Objective: The EERC proposes a project to directly address the intent of Section 25 of House Bill 1014 of the Sixty-Sixth Legislative Assembly of North Dakota which states that funds will be made available to the Energy & Environmental Research Center (EERC) "for pilot projects relating to the underground storage of produced natural gas." The goal of the proposed effort is to assess the viability of produced natural gas ("produced gas") injection into geologic targets in the Williston Basin as a mechanism to reduce flaring and achieve gas capture goals in Bakken oilfield locations with limited gas capture and transportation infrastructure. Several potential injection scenarios will be evaluated, including gas storage for future recovery and use, as well as injection into conventional or unconventional hydrocarbon reservoirs for pressure maintenance and enhanced oil recovery (EOR). To perform an in-depth evaluation of the concept, the EERC will partner with North Dakota oilfield producers on up to three pilot project efforts to define and assess the key technical, economic, and regulatory components of each approach.

Expected Results: The results of this effort will provide the state, the oil and gas industry, and other interested parties with the key information needed to assess the techno-economic viability of produced gas storage and/or injection into the subsurface as a means of achieving gas capture requirements, expanding Bakken oil production, and conserving the state's resources. Specifically, one or more pilot projects to demonstrate produced gas injection into subsurface storage or EOR targets would be highly beneficial to assess the details of the concept using real-world data on the technical, economic, and regulatory components of the approach.

Duration: The anticipated project duration is 25 months (June 1, 2019, to June 30, 2021).

Total Project Cost: $6,000,000

Participants: The EERC has existing relationships with many Bakken oil and gas producers, several of which have expressed interest in demonstrating the concept of produced gas storage. The EERC will work closely with its existing partners and the North Dakota Industrial Commission to identify potential opportunities to collaborate on produced gas injection pilot projects.

PROJECT DESCRIPTION

The Energy & Environmental Research Center (EERC) proposes a project to directly address the intent of Section 25 of House Bill 1014, of the Sixty-Sixth Legislative Assembly of North Dakota as signed into law by Governor Burgum (Appendix A) which states that funding will be made available to the EERC for "pilot projects relating to the underground storage of produced natural gas." The overall goal of the proposed effort is to demonstrate the techno-economic feasibility of produced natural gas ("produced gas") injection into non-hydrocarbon-producing subsurface formations in the Williston Basin for future recovery and use or for pressure maintenance and/or enhanced oil recovery (EOR) in a conventional or unconventional oil reservoir. To achieve the project goal, the EERC will partner with North Dakota oilfield producers on up to three pilot project efforts to define and assess the key technical, economic, and regulatory components of each approach.

Objectives: The primary project objectives will be to evaluate the viability of various subsurface formations as storage and/or injection targets, to document the facilities and equipment needs and costs for produced gas injection, to predict the subsurface storage footprint of the injected gas plume over time, to predict gas recovery efficiencies, to develop a monitoring plan, and to summarize the required regulatory considerations for different injection/storage scenarios. The above information will be obtained from a combination of research activities performed at the EERC and from up to three pilot projects performed in partnership with and including substantial financial investment from oil field operating companies.

Methodology: The project will be performed through a combination of research activities conducted at the EERC and in the field during the pilot projects. An overview of the key activities to be conducted by the EERC includes the following:

- Assessment of the key technical, economic, and regulatory components that are required to implement a pilot project for the following gas injection and/or storage scenarios:
  - Reinjection into the Bakken petroleum system (Bakken) for pressure maintenance and EOR.

  - Injection into a saline formation, such as the Broom Creek, for subsequent recovery and use.
  - Injection into a unitized conventional oil field for storage and/or EOR.
- Identification of one or more oilfield operating companies that are active in North Dakota and interested in partnering with the EERC to evaluate and demonstrate produced gas injection into the subsurface.
- Collaboration with the interested operating company (or companies) and North Dakota Industrial Commission's (NDIC's) Oil and Gas Division to conduct a field demonstration of one or more of the three gas injection scenarios described above and to further define and document all of the key technical, economic, and regulatory components necessary to implement subsurface storage of produced gas.
- Development of a plan that highlights optimal locations and scenarios for produced gas storage, recovery, and reuse throughout the oil- and gas-producing regions of North Dakota.

While the precise details of the pilot demonstration(s) will not be defined until the project partners are identified and specific injection scenarios and sites are determined, the EERC anticipates performing a combination of laboratory-, modeling-, and field-based activities to support and evaluate the concept of produced gas injection. The various activities to be performed by the EERC are summarized below.

Prior to implementing the gas injection pilot project, an initial site assessment will be performed for each location through data available at the EERC, through project partners, and through publically available data sets and websites. This information will be used to estimate the availability of produced gas at the site, the gas storage potential of the site, formation injectivity, gas compression requirements and general costs, availability of existing infrastructure to facilitate the pilot project, and additional infrastructure and/or equipment needs.

Once the initial site assessment is complete, additional work will be performed to elucidate the details of each pilot project. Laboratory-based activities will be performed to characterize the potential gas injection targets to better understand the gas storage potential of the target, to predict gas injection rates during the pilot, to determine the potential for imbibition and/or adsorption of the various gas

components within the reservoir, and to evaluate the overlying formation as a reservoir seal. If the goal of the pilot is to demonstrate EOR and storage in an oil reservoir, additional laboratory tests will be performed to evaluate the minimum miscibility pressure (MMP) required for effective EOR and to estimate the potential incremental oil recovery achieved by produced gas injection.

Laboratory results will be used to support development of geologic and reservoir simulation models of the injection targets to better define and estimate the injectivity of the target, the gas storage potential, gas and water recovery rates, stored gas plume extents in the formation and, if applicable, incremental oil recovery. The modeling and simulation results will be used to help design and inform the field demonstration tests.

The EERC will work closely with the project partners to determine the surface facilities and equipment required for produced gas injection and recovery, including the gas conditioning and compression requirements, brine disposal options, stored gas recovery system requirements and costs, and other surface-related infrastructure. Depending on the nature and duration of the pilot project, equipment rental options may also be evaluated as an alternative to purchasing equipment.

The EERC will also work closely with the project partners and the NDIC Department of Mineral Resources to define the key regulatory considerations for each pilot. The EERC will work closely with project partners to obtain the necessary permits for each pilot project and to review and implement any site monitoring requirements.

Throughout the duration of each pilot project, the EERC will collect all of the relevant data and results to assess the overall technical and economic performance of the approach. The results of the gas injection scenarios that are technically and economically feasible will be used to develop an implementation plan that highlights optimal locations and scenarios for produced gas storage, recovery, and reuse throughout the oil and gas production regions of North Dakota. Key lessons learned from the pilot projects will be incorporated into that plan for future development efforts.

Anticipated Results: The results of this effort will provide the state, the oil and gas industry, and other interested parties the information needed to assess the techno-economic viability of produced gas storage

and/or injection into the subsurface as a means of achieving gas capture goals, expanding Bakken oil production, conserving the state's resources, and potentially providing options for gas reuse through aggregation and the creation of stable gas storage reservoirs. Specifically, one or more pilot projects to demonstrate produced gas injection into a subsurface storage or EOR target would be highly beneficial to better define the permitting process; evaluate gas injectivity; assess the performance of high-pressure compressors for rich gas injection; evaluate gas and water recovery rates; and better define the technical, economic, and regulatory components of the approach. A techno-economic assessment of various gas reuse options and opportunities created by gas aggregation and storage will also be performed.

Facilities and Resources: The EERC employs a multidisciplinary staff of about 200 and has 254,000 square feet of state-of-the-art offices, laboratories, and technology demonstration facilities. EERC engineering and scientific research staff members are equipped with state-of-the-art analytical, modeling, and engineering facilities, which enable them to address a wide variety of energy, environmental, and mineral resource research topics. The EERC houses eight analytical laboratories dedicated to research, including water resource characterization; conventional and unconventional petroleum resources; environmental chemistry; and carbon capture, utilization, and storage. The EERC has extensive geologic modeling and reservoir simulation capabilities, including multiple high-end workstation computers and a dedicated high-performance parallel computing cluster. The project team has access to commercial-grade software for use in geophysical data interpretation, geologic modeling, and numerical simulation; database capabilities for managing data that will be collected and generated during the project; and GIS (geographic information system) software for creating high-quality maps and images of results. The EERC has designed and implemented field activities that include produced and injected fluid sampling and analysis; geophysical surveys and time-lapse surveillance of miscible EOR performance; pulsed-neutron logging to monitor saturation changes in oil reservoirs; lidar (light detection and ranging) and InSAR (interferometric synthetic aperture radar) monitoring to understand pattern performance; and continuous downhole pressure and temperature monitoring, drilling, and completion.

Techniques to Be Used, Their Availability and Capability: The EERC possesses a number of laboratory facilities that will be utilized through this effort for routine and advanced core analysis, including petrophysical, petrographic, geochemical and geomechanical rock analysis. Rich gas testing will also be conducted at the EERC, including MMP, permeability, and adsorption testing at reservoir conditions using methane, ethane, propane, or customized gas blends. Mobile chemistry and gas analysis laboratories owned by the EERC may also be employed to conduct quick turnaround analyses in the field at the pilot sites. It is anticipated that the EERC will assist with field monitoring activities, including monitoring of the injected gas plume using advanced downhole detection techniques such as pulsed neutron logging (PNL). Ms. Beth Kurz oversees the EERC's laboratories and will ensure that they are available for use during this effort.

Environmental and Economic Impacts while Project is Underway: The key environmental and economic impacts while this effort is under way are anticipated to be a reduction in produced gas that would have otherwise been flared and potential incremental oil recovery if injection occurs in a hydrocarbon-bearing zone. If stored gas is recovered from one of the pilots, brine will also be produced which will require disposal at a commercial (or dedicated) saltwater disposal facility. Additional potential environmental impacts are difficult to predict until specific pilot projects and associated scopes of work are identified. Environmental and economic impacts will be managed as necessary and mitigated within each task scope.

Ultimate Technological and Economic Impacts: At the end of 2018, basinwide estimates of voluntarily curtailed oil production were as high as 80,000 bbl/day,[1] as oil companies are faced with the challenges of meeting gas capture requirements. Depending on the magnitude, timing, and approach used for gas storage, the potential benefits can be on the order of tens of millions of dollars. For example, based on a 2018 study conducted at the EERC,[1] if produced gas storage were implemented proactively to allow for additional well development on DSUs (drill spacing units) with limited gas capture pipeline capacity, the

[1] Kurz, B.A., Jiang, T., Wocken, C.A., Peck, W.D., Schlasner, S.M., Oster, B.S., Bosshart, N.W., McRae, T.A., Gorecki, C.D., Harju, J.A., and Steadman, E.N., 2018, Evaluation of subsurface produced gas injection: Final report provided to the North Dakota Industrial Commission in Fulfillment of Contract No. G-000-004, 66 p.

economic benefit could be as high as $200 million. This was based on the value of the oil produced from wells that would otherwise have been delayed in development or been forced to curtail oil production.

The proposed effort will provide a detailed assessment of one or more produced gas injection approaches using real-world data to fully define the key technical, economic, and regulatory aspects of the concept. The implementation plan developed through this effort will provide a road map for other interested producers that includes key lessons learned and highlights optimal locations and scenarios for produced gas storage, recovery, and reuse in western North Dakota. The effort will also identify potential gas reuse and value-added opportunities for the state that arise from the accumulation of gas volumes large enough and stable enough to be used for EOR, petrochemical development, dry gas utilization, or NGL (natural gas liquid) recovery.

Why the Project is Needed: Extraction of oil and gas from the Bakken has dramatically increased over the past decade without commensurate augmentation of gas capture infrastructure, which has resulted in increased flaring of produced gas. In the face of increasing production, industry is experiencing challenges in meeting the current gas capture target of 88%, resulting in significant volumes of curtailed oil production. Temporary subsurface gas storage is a mechanism that can alleviate flaring and/or allow for additional wells to come online where pipeline capacity is limited. It allows time for additional gas capture and transportation infrastructure to come online and provides a mechanism for industry to accumulate volumes of gas large enough to be used for EOR, petrochemical development, dry gas utilization, or NGL recovery.

Through this effort, the EERC will work closely with industry and NDIC to evaluate the technical, economic, and regulatory aspects of produced gas storage through the implementation of up to three gas storage pilot projects. By demonstrating this concept in the field, the techno-economics of the process can be fully evaluated from start to finish and provide the baseline data and information to inform future field-scale implementation efforts.

STANDARDS OF SUCCESS

Success will be measured in the program's ability to evaluate and demonstrate the techno-economic feasibility of produced gas storage as a mechanism to reducing flaring and to limit curtailment of oil production. Demonstration of a technically and economically viable alternative to flaring would provide the state and producers with options to address one of the oil and gas industry's critical issues, ultimately resulting in more efficient resource development and cost savings. Developing options to help ensure the success of the oil and gas industry in North Dakota while conserving the state's resources leads to a strong state economy and the creation of jobs to support all aspects of oil and gas development. Key measures of success will be the implementation and evaluation of at least one pilot project and the development of a plan that provides a road map for producers to implement produced gas storage, including key lessons learned and highlighting optimal locations and scenarios for produced gas storage, recovery, and reuse in western North Dakota. Success will also be measured by adhering to the established project plan which will detail key project milestones and deliverables.

BACKGROUND/QUALIFICIATIONS

Energy & Environmental Research Center: The EERC is a high-tech, nonprofit branch of the University of North Dakota, exclusively conducting contract research for a multinational client base. The EERC's oil and gas experience is highlighted within the Center for Oil and Gas, a specialized technical group focusing on design and implementation of new approaches to the exploration, development, and production of oil and gas, including CO_2- and produced gas-based EOR and associated storage. In December of 2018, the EERC completed a techno-economic evaluation of produced gas storage and recovery from geologic targets in the Williston Basin [1] and is currently partnering with NDIC, Liberty Resources, and the U.S. Department of Energy on a project to evaluate rich gas injection into the Bakken for EOR. Additional EERC efforts are focused on evaluating permeation and adsorption of methane, ethane, and propane within Bakken Formation samples. The EERC has also completed studies on

enhanced utilization of produced gas and in supplying power to drilling rigs via bifueled utilization of associated gas.

Personnel: Resumes of key personnel are provided in Appendix A. Bethany Kurz, EERC Assistant Director for Integrated Analytical Solutions, will serve as Program Manager. John Harju, EERC Vice President for Strategic Partnerships, and Charles Gorecki, Director for Subsurface R&D, will serve as Senior Program Advisors. Other key EERC personnel include James Sorensen, EERC Assistant Director for Subsurface Strategies; Chad Wocken, EERC Principal Engineer and Transformational Energy Group Lead; and Rob Klenner, EERC Principal Geoscientist. Ms. Kurz, Mr. Gorecki, Mr. Sorensen, and Mr. Klenner have years of experience working on projects involving CO_2 and/or rich gas injection for EOR and storage, and Mr. Wocken has overseen multiple research efforts involving flare gas mitigation and assessment of options for produced gas capture and utilization.

MANAGEMENT

The EERC manages over 200 contracts a year, with a total of more than 1300 clients in 53 countries. Systems are in place to ensure that projects are managed within budget, schedule, and scope. Bethany Kurz, EERC Assistant Director of Integrated Analytical Solutions, will oversee the entire program. She will be responsible for program coordination, guidance, and supervision to ensure consistent progress and adherence to budget and schedule constraints. Ms. Kurz will be assisted in management of program activities and tasks by Mr. Sorensen, Mr. Wocken, and Mr. Klenner. Quarterly reports will be submitted to NDIC 30 days after the end of each calendar quarter to provide timely highlights of ongoing research activities. At least one report will be provided to legislative management regarding the results and recommendations of the proposed effort.

TIMETABLE

This effort is proposed as a 25-month project beginning June 1, 2019, and ending June 30, 2021.

BUDGET

The total estimated cost for the proposed scope of work, as listed in HB 1040, is $6 million. The budget provided in the table was developed based on past experience with similar projects. Once specific pilot test(s) projects are identified, attendant detailed budgets will be developed. At this time, cost share is not specifically proposed/enumerated; however, it is expected that pilot project partners will provide substantial cost share that will be documented to the greatest possible degree. Budget notes are included in Appendix C.

Project Associated Expense	NDIC OGRP
Labor	$2,990,446
Travel	$83,261
Supplies	$37,000
Rental Fees – Field Equipment	$560,000
Subcontractor – PNX Logging	$200,000
Communications	$907
Printing & Duplicating	$950
Food	$5,940
Laboratory Fees & Services	
Natural Materials Analytical Research Lab	$92,448
GC/MS Lab	$59,920
Graphics Services	$8,560
Outside Lab	$6,000
Total Direct Costs	$4,045,432
Facilities & Administration	$1,954,568
Total Cash Requested	$6,000,000

CONFIDENTIAL INFORMATION

There is no confidential information included in this proposal.

TAX LIABILITY

The EERC, a department within the University of North Dakota, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability to the state of North Dakota or any of its political subdivisions.

PATENTS/RIGHTS TO TECHNICAL DATA

No patentable technologies are expected to be created during this work.

STATUS OF ONGOING PROJECTS (IF ANY)

The EERC is currently engaged in thirteen NDIC-funded projects as shown in the table below. These projects are ongoing and current on all deliverables.

Project Title
Pipeline Study Phase III (HB 1347)
Pathway to Low-Carbon Lignite Utilization – Phases 1B and 2A
Project Carbon – Overcoming Barriers to the Implementation of Postcombustion Carbon Capture
AOI2 – Initial Engineering, Testing, and Design of a Commercial-Scale Postcombustion CO_2 Capture System on an Existing Coal-Fired Generating Unit
Low-Pressure Electrolytic Ammonia Production
iPIPE: Intelligent Pipeline Integrity Program
North Dakota Integrated Carbon Storage Complex Feasibility Study
Bakken Production Optimization Program
Integrated Carbon Capture and Storage for North Dakota Ethanol Production – Phase III
Bakken Rich Gas Enhanced Oil Recovery
Resource Characterization
Emerging Issues
Economic Extraction and Recovery of REEs and Production of Clean Value-Added Products from Low-Rank Coal Fly Ash

APPENDIX A

HOUSE BILL 1014

19.0202.04000

Sixty-sixth
Legislative Assembly
of North Dakota

Introduced by

Appropriations Committee

FIRST ENGROSSMENT
with Conference Committee Amendments
ENGROSSED HOUSE BILL NO. 1014

A BILL for an Act to provide for an appropriation for defraying the expenses of the industrial commission and the agencies under the management of the industrial commission; to create and enact a new section to chapter 6-09 of the North Dakota Century Code, relating to a rebuilders home loan program; to amend and reenact section 54-17-40 and subdivision f of subsection 1 of section 57-51-15 of the North Dakota Century Code and section 7 of House Bill No. 1435, as approved by the sixty-sixth legislative assembly, relating to the housing incentive fund, the fund balance of the abandoned oil and gas well plugging and site reclamation fund, and a transfer to the statewide interoperable radio network fund; to provide a contingent authorization; to provide for a transfer; to provide for a contingent transfer; to provide an exemption; to provide for a report; to provide for a study; to provide a statement of legislative intent; and to declare an emergency.

BE IT ENACTED BY THE LEGISLATIVE ASSEMBLY OF NORTH DAKOTA:

SECTION 1. APPROPRIATION. The funds provided in this section, or so much of the funds as may be necessary, are appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, and from special funds derived from federal funds and other income to the industrial commission and agencies under its control for the purpose of defraying the expenses of the industrial commission and agencies under its control, for the biennium beginning July 1, 2019, and ending June 30, 2021, as follows:

Subdivision 1.

INDUSTRIAL COMMISSION

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$22,014,084	$1,570,366	$23,584,450
Operating expenses	5,305,888	794,339	6,100,227

Capital assets	0	5,000,000	5,000,000
Grants - bond payments	13,210,484	(2,701,717)	10,508,767
Contingencies	221,737	7,807	229,544
Total all funds	$40,752,193	$4,670,795	$45,422,988
Less estimated income	15,343,206	2,650,584	17,993,790
Total general fund	$25,408,987	$2,020,211	$27,429,198
Full-time equivalent positions	110.25	2.00	112.25

Subdivision 2.

BANK OF NORTH DAKOTA

	Base Level	Adjustments or Enhancements	Appropriation
Bank of North Dakota operations	$58,489,204	$4,358,595	$62,847,799
Capital assets	810,000	700,000	1,510,000
Total special funds	$59,299,204	$5,058,595	$64,357,799
Full-time equivalent positions	181.50	0.00	181.50

Subdivision 3.

HOUSING FINANCE AGENCY

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$7,892,056	$616,959	$8,509,015
Operating expenses	4,743,355	602,921	5,346,276
Grants	31,794,828	1,671,772	33,466,600
Housing finance agency contingencies	100,000	0	100,000
Total special funds	$44,530,239	$2,891,652	$47,421,891
Full-time equivalent positions	44.00	0.00	44.00

Subdivision 4.

MILL AND ELEVATOR ASSOCIATION

	Base Level	Adjustments or Enhancements	Appropriation
Salaries and wages	$39,308,519	$7,139,305	$46,447,824
Operating expenses	28,195,000	1,642,000	29,837,000

Contingencies	500,000	0	500,000
Agriculture promotion	210,000	0	210,000
Total special funds	$68,213,519	$8,781,305	$76,994,824
Full-time equivalent positions	153.00	3.00	156.00

Subdivision 5.

	BILL TOTAL		
	Base Level	Adjustments or Enhancements	Appropriation
Grand total general fund	$25,408,987	$9,540,211	$34,949,198
Grand total special funds	187,386,168	19,382,136	206,768,304
Grand total all funds	$212,795,155	$28,922,347	$241,717,502

SECTION 2. ONE-TIME FUNDING - EFFECT ON BASE BUDGET - REPORT TO THE SIXTY-SEVENTH LEGISLATIVE ASSEMBLY. The following amounts reflect the one-time funding items approved by the sixty-fifth legislative assembly for the 2017-19 biennium and the 2019-21 biennium one-time funding items included in the appropriation in section 1 of this Act:

One-Time Funding Description	2017-19	2019-21
Litigation	$1,000,000	$0
Industrial water supply asset study	150,000	0
Soil remediation studies	5,000,000	0
Survey review	800,000	0
Temporary employees	0	175,000
Rare earth elements study	0	160,000
Fracturing sand study	0	110,000
Oil database software upgrade	0	5,000,000
Total all funds	$6,950,000	$5,445,000
Less estimated income	6,950,000	5,270,000
Total general fund	$0	$175,000

The 2019-21 biennium one-time funding amounts are not a part of the entity's base budget for the 2021-23 biennium. The industrial commission shall report to the appropriations committees of the sixty-seventh legislative assembly on the use of this one-time funding for the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 3. BOND PAYMENTS. The amount of $10,508,767 included in subdivision 1 of section 1 of this Act in the grants - bond payments line item must be paid from the following funding sources during the biennium beginning July 1, 2019, and ending June 30, 2021:

North Dakota university system	$4,959,448
North Dakota university system - energy conservation projects	415,664
Department of corrections and rehabilitation	689,299
Department of corrections and rehabilitation - energy conservation projects	16,180
State department of health	644,884
Job service North Dakota	434,847
Office of management and budget	567,125
Attorney general's office	647,500
State historical society	1,177,875
Parks and recreation department	66,875
Research and extension service	483,337
Veterans' home	405,733
Total	$10,508,767

SECTION 4. APPROPRIATION - HOUSING FINANCE AGENCY - ADDITIONAL INCOME. In addition to the amount appropriated to the housing finance agency in subdivision 3 of section 1 of this Act, there is appropriated any additional income or unanticipated income from federal or other funds which may become available to the agency for the biennium beginning July 1, 2019, and ending June 30, 2021. The housing finance agency shall notify the office of management and budget and the legislative council of any additional income or unanticipated income that becomes available to the agency resulting in an increase in appropriation authority.

SECTION 5. APPROPRIATION - TRANSFER GENERAL FUND TO HIGH-LEVEL RADIOACTIVE WASTE FUND. There is appropriated out of any moneys in the general fund in the state treasury, not otherwise appropriated, the sum of $20,000, which the office of management and budget shall transfer to the high-level radioactive waste fund during the biennium beginning July 1, 2019, and ending June 30, 2021. The funding provided in this section is considered a one-time funding item.

SECTION 6. APPROPRIATION - TRANSFER GENERAL FUND TO HOUSING INCENTIVE FUND. There is appropriated out of any moneys in the general fund in the state

treasury, not otherwise appropriated, the sum of $7,500,000, which the office of management and budget shall transfer to the housing incentive fund during the biennium beginning July 1, 2019, and ending June 30, 2021. The funding provided in this section is considered a one-time funding item.

SECTION 7. CONTINGENT FUNDING - INDUSTRIAL COMMISSION. The amount of $229,544 from the general fund and two full-time equivalent positions included in subdivision 1 of section 1 of this Act may be spent only in accordance with the provisions of this section. The industrial commission shall notify the office of management and budget and the legislative council when the total number of wells capable of production and injection exceeds twenty thousand eight hundred. Subject to budget section approval, the industrial commission may spend $229,544 from the contingencies line item and may hire two full-time equivalent positions if the total number of oil wells capable of production and injection exceeds twenty thousand eight hundred.

SECTION 8. TRANSFER - ENTITIES UNDER THE CONTROL OF THE INDUSTRIAL COMMISSION TO INDUSTRIAL COMMISSION FUND. The sum of $1,172,603, or so much of the sum as may be necessary, included in the appropriation in subdivision 1 of section 1 of this Act, may be transferred from the entities within the control of the industrial commission or entities directed to make payments to the industrial commission fund for administrative services rendered by the commission. Transfers must be made during the biennium beginning July 1, 2019, and ending June 30, 2021, upon order of the commission. Transfers from the student loan trust fund must be made to the extent permitted by sections 54-17-24 and 54-17-25.

SECTION 9. TRANSFER - BANK OF NORTH DAKOTA PROFITS TO GENERAL FUND. The industrial commission shall transfer to the general fund $140,000,000 from the current earnings and the accumulated profits of the Bank of North Dakota during the biennium beginning July 1, 2019, and ending June 30, 2021. The moneys must be transferred in the amounts and at the times requested by the director of the office of management and budget after consultation with the Bank of North Dakota president. For legislative council budget status reporting purposes, the transfer under this section is considered an ongoing revenue source.

SECTION 10. TRANSFER - PARTNERSHIP IN ASSISTING COMMUNITY EXPANSION. The Bank of North Dakota shall transfer the sum of $26,000,000, or so much of the sum as may be necessary, from the Bank's current earnings and undivided profits to the partnership in

assisting community expansion fund during the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 11. TRANSFER - AGRICULTURE PARTNERSHIP IN ASSISTING COMMUNITY EXPANSION. The Bank of North Dakota shall transfer the sum of $4,000,000, or so much of the sum as may be necessary, from the Bank's current earnings and undivided profits to the agriculture partnership in assisting community expansion fund during the period beginning with the effective date of this Act and ending June 30, 2021. The Bank may use up to $1,000,000 of the funding provided in this section to expand the parameters for the agriculture partnership in assisting community expansion program to assist farmers and livestock producers that suffered extraordinary losses related to river flooding in the state due to ice jams in the winter and spring of 2019 for the period beginning with the effective date of this Act and ending June 30, 2021.

SECTION 12. TRANSFER - BIOFUELS PARTNERSHIP IN ASSISTING COMMUNITY EXPANSION. The Bank of North Dakota shall transfer the sum of $1,000,000, or so much of the sum as may be necessary, from the Bank's current earnings and undivided profits to the biofuels partnership in assisting community expansion fund during the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 13. TRANSFER - BEGINNING FARMER REVOLVING LOAN FUND. The Bank of North Dakota shall transfer the sum of $6,000,000, or so much of the sum as may be necessary, from the Bank's current earnings and undivided profits to the beginning farmer revolving loan fund during the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 14. TRANSFER - NORTH DAKOTA DEVELOPMENT FUND. The Bank of North Dakota shall transfer the sum of $15,000,000, or so much of the sum as may be necessary, from the Bank's current earnings and undivided profits to the North Dakota development fund established under chapter 10-30.5 during the biennium beginning July 1, 2019, and ending June 30, 2021. Funding transferred under this section must be used to purchase existing venture capital assets held by the Bank of North Dakota.

SECTION 15. TRANSFER - REBUILDERS LOAN PROGRAM PAYMENTS TO REBUILDERS HOME LOAN FUND. From the principal payments received under the rebuilders loan program established in section 6-09-46, which were designated to replenish the Bank of North Dakota's current earnings and undivided profits pursuant to section 3 of chapter 83 of the 2013 Session Laws, the Bank shall transfer the sum of $3,750,000 to the rebuilders home loan

fund during the period beginning with the effective date of this Act and ending June 30, 2021. Any funds not committed to loans by September 30, 2020, must be returned to the Bank's current earnings and undivided profits.

SECTION 16. CONTINGENT TRANSFER - STRATEGIC INVESTMENT AND IMPROVEMENTS FUND TO INFRASTRUCTURE REVOLVING LOAN FUND. The office of management and budget shall transfer up to $40,000,000 of any oil and gas tax revenues deposited in the strategic investment and improvements fund during the period August 1, 2017, through July 31, 2019, exceeding $755,000,000, from the strategic investment and improvements fund to the infrastructure revolving loan fund established under section 6-09-49, during the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 17. ESTIMATED INCOME - STRATEGIC INVESTMENT AND IMPROVEMENTS FUND. The operating expenses line item and the estimated income line item in subdivision 1 of section 1 of this Act include $270,000 from the strategic investment and improvements fund for a rare earth element study and a fracturing sand study.

SECTION 18. ESTIMATED INCOME - ABANDONED OIL AND GAS WELL PLUGGING AND SITE RECLAMATION FUND. The capital assets line item and the estimated income line item in subdivision 1 of section 1 of this Act include $5,000,000 from the abandoned oil and gas well plugging and site reclamation fund for a risk-based data management system information technology project.

SECTION 19. OIL AND GAS RESEARCH FUND - RECYCLING PRODUCED WATER STUDY - REPORT TO LEGISLATIVE MANAGEMENT. Pursuant to the continuing appropriation in section 57-51.1-07.3, the industrial commission shall use $300,000, or so much of the sum as may be necessary, from the oil and gas research fund to contract with the sponsor of the proposal selected for the study. The industrial commission shall issue a request for proposals for a study regarding the recycling of water used in oil and gas operations, also known as produced water, from oil and gas-producing regions of North Dakota. The study must include the development or compilation of data regarding methods for the recycling of produced water specific to this state, and must examine the relevant, objective economic, regulatory, scientific, technological, and feasibility considerations. The contractor shall provide reports on the status of the study at the request of the legislative management during the 2019-20 interim and shall provide a final report to the legislative management by October 1, 2020.

SECTION 20. A new section to chapter 6-09 of the North Dakota Century Code is created and enacted as follows:

Rebuilders home loan program - Rebuilders home loan fund - Continuing appropriation - Requirements.

1. There is created in the state treasury the rebuilders home loan fund administered by the Bank of North Dakota. The fund consists of all moneys transferred to the fund by the legislative assembly. All moneys in the fund are appropriated to the Bank on a continuing basis for the rebuilders home loan program.
2. The Bank shall develop policies to implement this section. The Bank shall make or participate in loans to North Dakota residents affected by river flooding in the state due to ice jams in the winter and spring of 2019. Loans are available for rebuilding the resident's flood-damaged home or rebuilding nonowner-occupied property. A loan from the fund must have the interest rate fixed at one percent per year for no more than twenty years. A loan made to a homeowner or owner of nonowner-occupied property under this section may not exceed the lesser of seventy-five thousand dollars or the actual amount of documented damage not paid by flood insurance. For purposes of this section, "nonowner-occupied property" means property consisting of one or more rental dwelling units, none of which is occupied by the owner, and does not include hotel or motel accommodations or any other commercial property. For a resident rebuilding the resident's flood-damaged home, up to twenty percent of the loan proceeds disbursed under this program may be used for debt service, debt retirement, or other credit obligations. For every loan made from the fund to a homeowner to rebuild or replace that individual's flood-damaged home, principal and interest payments must be deferred for the first twenty-four months of the loan. There is no deferral of principal and interest payments for a loan for nonowner-occupied property.
3. A resident homeowner or owner of nonowner-occupied property is eligible for a loan under this section only if the home or property is located in an area affected by river flooding in the state due to ice jams in the winter and spring of 2019. To qualify for a loan under this section, the owner of nonowner-occupied property must have been the owner at the time of the flooding event, and the number of rental dwelling units in the property rebuilt under this section must remain the same as before the flooding event.

A loan to the owner of nonowner-occupied property must be secured by the property for which the loan is made.

4. An application for a loan from the fund must be made to the Bank or originating financial institution, and, upon approval, a loan must be made from the fund in accordance with this section. An application for a loan to a homeowner or for a loan for nonowner-occupied property under this section may not be accepted after September 30, 2020.

5. Repayments to the rebuilders home loan fund must be transferred annually to replenish the Bank's current earnings and undivided profits which were transferred to the rebuilders home loan fund. If, subsequent to receiving a loan from the fund, the property for which the loan was made is purchased for flood mitigation purposes or otherwise sold, the balance of the loan and any interest accrued on the loan must be repaid to the fund upon the closing of the sale. If the borrower provides financial evidence satisfactory to the Bank to show that the borrower does not have the financial ability to repay the loan in full upon sale of the property, after the sale of the property the Bank may allow the borrower to continue to make payments based on the loan terms.

6. The Bank may deduct, from interest payments received on loans, a service fee for administering the fund for the Bank and originating financial institutions. The Bank shall contract with a certified public accounting firm to audit the fund as necessary. The cost of the audit, and any other actual costs incurred by the Bank on behalf of the fund, must be paid by the fund.

SECTION 21. AMENDMENT. Section 54-17-40 of the North Dakota Century Code is amended and reenacted as follows:

54-17-40. Housing incentive fund - Continuing appropriation - Report to budget section.

1. The housing incentive fund is created as a special revolving fund at the Bank of North Dakota. The housing finance agency may direct disbursements from the fund and a continuing appropriation from the fund is provided for that purpose.

2. a. After a public hearing, the housing finance agency shall create an annual allocation plan for the distribution of the fund. At least ~~twenty-five~~fifteen percent of

the fund must be used to assist developing communities to address an unmet housing need or alleviate a housing shortage.

b. The annual allocation plan must give ~~first~~ priority ~~through its scoring and ranking process to housing for essential service workers. For purposes of this subsection, "essential service workers" means individuals employed by a city, county, school district, medical or long-term care facility, the state of North Dakota, or others as determined by the housing finance agency who fulfill an essential public service.~~

~~c.~~ ~~The second priority in the annual allocation plan must be~~ to provide housing for individuals and families of low or moderate income. For purposes of this ~~second~~ priority, eligible income limits are determined as a percentage of median family income as published in the most recent federal register notice. Under this ~~second~~ priority, the annual allocation plan must give preference to projects that benefit households with the lowest income and to projects that have rent restrictions at or below department of housing and urban development published federal fair market rents or department of housing and urban development section 8 payment standards.

3. The housing finance agency shall adopt guidelines for the fund so as to address unmet housing needs in this state. Assistance from the fund may be used solely for:
   a. New construction, rehabilitation, or acquisition of a multifamily housing project;
   b. Gap assistance, matching funds, and accessibility improvements;
   c. Assistance that does not exceed the amount necessary to qualify for a loan using underwriting standards acceptable for secondary market financing or to make the project feasible; and
   d. Rental assistance, emergency assistance, or targeted supportive services designated to prevent homelessness.
4. Eligible recipients include units of local, state, and tribal government; local and tribal housing authorities; community action agencies; regional planning councils; and nonprofit organizations and for-profit developers of multifamily housing. Individuals may not receive direct assistance from the fund.
5. Except for subdivision d of subsection 3, assistance is subject to repayment or recapture under the guidelines adopted by the housing finance agency. Any

assistance that is repaid or recaptured must be deposited in the fund and is appropriated on a continuing basis for the purposes of this section.

6. The agency may collect a reasonable administrative fee from the fund, project developers, applicants, or grant recipients. The origination fee assessed to grant recipients may not exceed five percent of the project award.

7. ~~The housing finance agency shall maintain a register reflecting the number of housing units owned or master leased by cities, counties, school districts, or other employers of essential service workers. This register must also reflect those entities that are providing rent subsidies for their essential workers.~~

~~8.~~ Upon request, the housing finance agency shall report to the industrial commission regarding the activities of the housing incentive fund.

~~9.~~8. At least once per biennium, the housing finance agency shall provide a report to the budget section of the legislative management regarding the activities of the housing incentive fund. ~~The report must include the following:~~

~~a. The overall number of units owned, master leased, or subsidized by political subdivisions or other employers of essential service workers; and~~

~~b. A listing of projects approved and the number of units within those projects that provide housing for essential service workers.~~

SECTION 22. AMENDMENT. Subdivision f of subsection 1 of section 57-51-15 of the North Dakota Century Code is amended and reenacted as follows:

f. (1) For the period beginning September 1, 2017, and ending August 31, 2019, the state treasurer shall allocate four percent of the amount available under this subsection to the abandoned oil and gas well plugging and site reclamation fund, but not in an amount exceeding four million dollars per fiscal year and not in an amount that would bring the balance in the fund to more than ~~one hundred~~fifty million dollars.

(2) After August 31, 2019, the state treasurer shall allocate four percent of the amount available under this subsection to the abandoned oil and gas well plugging and site reclamation fund, but not in an amount exceeding seven million five hundred thousand dollars per fiscal year and not in an amount

that would bring the balance in the fund to more than ~~one hundred~~fifty million dollars.

SECTION 23. AMENDMENT. Section 7 of House Bill No. 1435, as approved by the sixty-sixth legislative assembly, is amended and reenacted as follows:

SECTION 7. TRANSFER - BANK OF NORTH DAKOTA PROFITS - STATEWIDE INTEROPERABLE RADIO NETWORK FUND. ~~The~~After other moneys in the statewide interoperable radio network fund, the transfer of $20,000,000 from the strategic investment and improvements fund, and the $80,000,000 line of credit have been used, the industrial commission shall transfer the sum of $20,000,000 from the current earnings and accumulated undivided profits of the Bank of North Dakota to the statewide interoperable radio network fund, during the period beginning with the effective date of this Act, and ending June 30, 2021.

SECTION 24. EXEMPTION - OIL AND GAS TAX REVENUE ALLOCATIONS - NORTH DAKOTA OUTDOOR HERITAGE FUND. Notwithstanding the provisions of section 57-51-15 relating to the allocations to the North Dakota outdoor heritage fund, for the period beginning September 1, 2019, and ending August 31, 2021, the state treasurer shall allocate eight percent of the oil and gas gross production tax revenue available under subsection 1 of section 57-51-15 to the North Dakota outdoor heritage fund, but not in an amount exceeding $7,500,000 per fiscal year.

SECTION 25. EXEMPTION - OIL AND GAS TAX REVENUE ALLOCATIONS - OIL AND GAS RESEARCH FUND - PILOT PROJECT FOR UNDERGROUND GAS STORAGE.

1. Notwithstanding the provisions of section 57-51.1-07.3 relating to the allocations to the oil and gas research fund, for the period beginning August 1, 2019, and ending July 31, 2021, the state treasurer shall deposit two percent of the oil and gas gross production tax and oil extraction tax revenues, up to $16,000,000, into the oil and gas research fund before depositing oil and gas tax revenues under section 57-51.1-07.5.
2. Pursuant to the continuing appropriation in section 57-51.1-07.3, the industrial commission shall use $6,000,000, or so much of the sum as may be necessary, from the oil and gas research fund to contract with the energy and environmental research center for pilot projects relating to the underground storage of produced natural gas. The pilot projects may include studies and demonstration projects. During the 2019-20

interim, the energy and environmental research center shall provide quarterly reports to the industrial commission and at least one report to the legislative management regarding the results and recommendations of the pilot project.

SECTION 26. EXEMPTION - INDUSTRIAL COMMISSION FUND. The amount of $1,103,779 appropriated to the industrial commission in subdivision 1 of section 1 of chapter 39 of the 2017 Session Laws and transferred pursuant to section 8 of chapter 39 of the 2017 Session Laws is not subject to the provisions of section 54-44.1-11. Any unexpended funds from this appropriation are available to the industrial commission for administrative services rendered by the commission during the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 27. EXEMPTION - SURVEY REVIEW - STRATEGIC INVESTMENT AND IMPROVEMENTS FUND. The amount of $800,000 appropriated from the strategic investment and improvements fund in section 2 of chapter 426 of the 2017 Session Laws is not subject to section 54-44.1-11. Any unexpended funds from this appropriation are available to the industrial commission for expert legal testimony associated with the survey review during the biennium beginning July 1, 2019, and ending June 30, 2021.

SECTION 28. LIGNITE RESEARCH, DEVELOPMENT, AND MARKETING PROGRAM - LIGNITE MARKETING FEASIBILITY STUDY. The amount of $4,500,000 from the lignite research fund, or so much of the amount as may be necessary, may be used for the purpose of contracting for an independent, nonmatching lignite marketing feasibility study or studies that determine those focused priority areas where near-term, market-driven projects, activities, or processes will generate matching private industry investment and have the most potential of preserving existing lignite production and industry jobs or that will lead to increased development of lignite and its products and create new lignite industry jobs and economic growth for the general welfare of this state. Moneys appropriated pursuant to this section also may be used for the purpose of contracting for nonmatching studies and activities in support of the lignite vision 21 program; for litigation that may be necessary to protect and promote the continued development of lignite resources; for nonmatching externality studies and activities in externality proceedings; or other marketing, environmental, or transmission activities that assist with marketing of lignite-based electricity and lignite-based byproducts. Moneys needed for the

purposes stated in this section are available to the industrial commission for funding projects, processes, or activities under the lignite research, development, and marketing program.

SECTION 29. HEDGING STRATEGIES STUDY - BANK OF NORTH DAKOTA - REPORT TO LEGISLATIVE ASSEMBLY. During the 2019-20 interim, the Bank of North Dakota shall conduct a study on the use of various hedging strategies to protect the state from volatile swings in oil prices. Before January 15, 2021, the Bank of North Dakota shall report the results of its study to the appropriations committees of the sixty-seventh legislative assembly.

SECTION 30. LEGISLATIVE INTENT - LIGNITE RESEARCH FUND - LIGNITE LITIGATION. It is the intent of the sixty-sixth legislative assembly that at least $500,000 of the funding in section 28 of this Act and any funding deposited in the lignite research fund related to successful litigation is available from the lignite research fund to be used to pay fees associated with lignite litigation that may be brought by the state to protect and promote the continued development of lignite resources.

SECTION 31. EMERGENCY. Sections 11, 15, and 20 of this Act are declared to be an emergency measure.

APPENDIX B

RESUMES OF KEY PERSONNEL

BETHANY A. KURZ
Assistant Director for 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
Phone: (701) 777-5050, Fax: (701) 777-5181, E-Mail: bkurz@undeerc.org

Principal Areas of Expertise

Ms. Kurz's principal areas of interest and expertise include geologic and geochemical characterization of subsurface media for carbon storage and/or CO_2-based enhanced oil recovery, produced water and drilling waste management, assessment of high-value materials in coal and produced brine, and resource management related to energy development.

Qualifications

M.S., Hydrogeology, University of North Dakota, Grand Forks, ND, 1998.
B.S., Geochemistry, Bridgewater State University, Bridgewater, MA, 1995.

Professional Experience

July 2018–Present: Assistant Director for Integrated Analytical Solutions, EERC, UND. Ms. Kurz is responsible for assisting the EERC's management team with developing business opportunities and successfully executing research projects related to oil and gas; natural resource management; and carbon capture, utilization, and storage. She oversees a multidisciplinary team of scientists and engineers who work in the EERC's applied research laboratories. In that role, she is responsible for ensuring the quality assurance/quality control of data and results generated by the EERC's 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. Ms. Kurz oversaw a multidisciplinary team of scientists and engineers and several of the EERC's 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. Her 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. Ms. Kurz's responsibilities included project management, technical report and proposal writing, public outreach, and the development of new research focus areas. Research activities included the 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. Ms. Kurz's 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 and Presentations
Has coauthored more than 60 professional publications and presentations

JOHN A. HARJU
Vice President for Strategic Partnerships
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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 coursework 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.

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 core research priorities: coal utilization and emissions, carbon management, oil and gas, alternative fuels and renewable energy, and energy–water.

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

2002–2003: Senior Research Advisor. Mr. Harju developed, marketed, managed, and disseminated research programs focused on the environmental and health effects of power and natural resource production, contaminant cleanup, water management, and analytical techniques.

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

1999–2002: Vice President, Crystal Solutions, LLC, Laramie, WY. 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, IL.
2000–2002: Principal Scientist, Produced Water Management. Mr. Harju developed and deployed 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 managed projects and programs related to the development of environmental technologies and informational products related to the North American oil and gas industry; formulated RFPs, reviewed proposals, and formulated contracts; performed technology transfer activities; and supervised staff and contractors. He served as Manager of the Environmentally Acceptable Endpoints project, a multiyear program focused on rigorous determination of appropriate cleanup levels for hydrocarbons and other energy-derived contaminants in soils. He led GRI/GTI involvement with industry environmental consortia and organizations, such as PERF, SPE, AGA, IPEC, and API.

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

1988–1996: EERC, UND.
1994–1996: Senior Research Manager, Oil and Gas Group. Mr. Harju served as:
- Program Manager for assessment of 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 of the National Mine Land Reclamation Center for the Western Region.
- Co-PI on project exploring feasibility of underground coal gasification in southern Thailand.
- Consultant to an International Atomic Energy Agency program entitled "Solid Wastes and Disposal Methods Associated with Electricity Generation Fuel Chains."

1988–1994: Research Manager (1994), Hydrogeologist (1990–1994), Research Specialist (1989–1990), and Laboratory Technician (1988–1989).

Professional Memberships
National Coal Council (appointed 2018)
National Petroleum Council (appointed 2010)
Mainstream Investors, LLC, Board of Governors (2014–present)
DOE Unconventional Resources Technology Advisory Committee (2012–2014)
Interstate Oil and Gas Compact Commission (appointed 2010)
Rocky Mountain Association of Geologists

Publications and Presentations
Has authored or coauthored more than 100 professional publications and nearly 300 technical presentations.

CHARLES D. GORECKI
Director of Subsurface R&D
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
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Principal Areas of Expertise
Mr. Gorecki's principal areas of interest and expertise include enhanced oil recovery (EOR), unconventional oil and gas research, and the geologic storage of CO_2.

Qualifications
B.S., Geological Engineering, University of North Dakota, 2007.

Professional Experience
2015–Present: Director of Subsurface R&D, EERC, UND. Mr. Gorecki is responsible for developing and managing programs and projects focused on conventional, unconventional, and enhanced oil and gas production; the geologic storage of CO_2; geothermal; and other energy and environmental research. He currently serves as the Program Manager for the Plains CO_2 Reduction (PCOR) Partnership, one of seven regional partnerships funded by the U.S. Department of Energy's (DOE's) National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program. The PCOR Partnership Program is a three-phase, multiyear, multimillion-dollar program, focused on assessing the technical and economic feasibility of capturing and storing CO_2 emissions from stationary sources in the northern Great Plains and adjacent area. Under this program, Mr. Gorecki leads a multidisciplinary team of researchers working primarily on developing monitoring, verification, and accounting concepts and technologies for large-scale CO_2 storage (>1 million tons per year) in deep saline formations and oil fields and the characterization of the geologic formations in the PCOR Partnership region in preparation for the implementation of the commercial deployment of carbon capture and storage (CCS).

In addition to the PCOR Partnership Program, Mr. Gorecki also manages or oversees projects related to CO_2 storage capacity estimation, novel reservoir surveillance and CO_2 storage monitoring techniques, and unconventional oil and gas resource modeling, characterization, and testing. He has also led several other national and international projects associated with CO_2 storage, the nexus of water and CCS, and CO_2 EOR.

2011–2015: Senior Research Manager, EERC, UND. Mr. Gorecki was the manager of the PCOR Partnership and the technical lead for the Bell Creek CO_2 EOR field demonstration. Mr. Gorecki led the geologic modeling and simulation efforts for the EERC as well as national and international efforts associated with the nexus of water and CCS. He led efforts focused on developing storage capacity estimates and methodologies for deep saline formations and hydrocarbon reservoirs. In addition, Mr. Gorecki has led and worked on detailed site characterization, modeling, risk assessment, and monitoring activities for both EOR projects and CO_2 storage operations in deep saline formations. He participated in several expert review committees and was involved in developing a methodology for estimating CO_2 storage capacity in deep saline formations, oil and gas reservoirs, and shale formations for DOE.

2010–2011: Research Manager, EERC, UND. Mr. Gorecki led the modeling and monitoring and Water Working Group tasks for Phase III of the PCOR Partnership Program. He led the EERC's geologic modeling efforts, coordinating a multidisciplinary team to develop detailed geologic models and run

predictive simulations for CO_2 storage, CO_2 EOR, and unconventional oil and gas plays. Mr. Gorecki was also the facilitator of the Regional Carbon Sequestration Partnership Water Working Group, where he led discussion on the nexus of water and CCS.

2007–2010: Research Engineer, EERC, UND. Mr. Gorecki worked with the PCOR Partnership at the EERC to develop models to describe the behavior of CO_2 prior to injection into saline formations and oil fields. Mr. Gorecki led a joint venture funded by the IEA Greenhouse Gas R&D Programme and DOE to develop storage capacity/ resource coefficients to determine CO_2 storage capacity/resource estimates in saline formations. As a result of Mr. Gorecki's work in developing storage capacity/resource estimates, he served on the expert review panel on the U.S. Geological Survey's CO_2 Capacity Methodology; advised and helped to develop methodologies for the North American Energy Working Group's CO_2 storage capacity efforts between the United States, Canada, and Mexico; and advised the DOE National Energy Technology Laboratory on the third edition of the Carbon Sequestration Atlas of the United States and Canada.

Professional Memberships
American Association of Petroleum Geologists, 2009–Present
Society of Petroleum Engineers, 2007–Present
Member of European Association of Geoscientists and Engineers, 2014–Present

Publications and Presentations
Mr. Gorecki has authored and coauthored many papers and given presentations on a variety of topics associated with CO_2 EOR and CO_2 storage in the United States and throughout the world.

JAMES A. SORENSEN
Assistant Director for Subsurface Strategies
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Principal Areas of Expertise
Mr. Sorensen's 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.

Education
B.S., Geology, University of North Dakota, 1991.
Postgraduate course work in Geology and Hydrogeology, 1993–1995.

Professional Experience
July 2018–Present: Assistant Director for Subsurface Strategies, EERC, UND. Mr. Sorensen develops business opportunities, provides technical support and guidance regarding emerging areas of research, and serves as a principal investigator 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. Mr. Sorensen served as manager and co-principal investigator for programs to develop strategies for CO_2 utilization and storage. He also led research focused on enhanced oil recovery (EOR) in the Bakken.

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

1993–1997: Geologist, EERC, UND. Mr. Sorensen conducted field-based hydrogeologic investigations focused on 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.

CHAD A. WOCKEN
Principal Engineer, Transformational Energy Group Lead
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Principal Areas of Expertise

Mr. Wocken's principal areas of research include developing alternative fuel and chemical processes and innovative energy technologies. Currently, he is leading projects focused on developing and advancing alternative chemical and fuel production processes at the bench, lab, and pilot scale; and optimizing processes associated with oil and gas production and midstream operations. Mr. Wocken currently manages a group of researchers and a lab facility containing batch and continuous reactor systems capable of testing a variety of thermochemical processes.

Qualifications

B.S., Chemical Engineering, University of North Dakota, 1994
Certifications: U.S. Army Corps of Engineers Construction Quality Management, 40-hour OSHA Health and Safety, 8-hour HAZWOPER Supervisor, 10-hour Construction Safety and Health.

Professional Experience

2009–Present: Principal Engineer, Transformational Energy Group Lead (2009–September 2015, Senior Research Manager; 2001–2009, Research Engineer), EERC, UND.

Project/Program Management

- Created a process-modeling team within the EERC's Bakken Production Optimization Program, focused on applying computational modeling expertise to oil well production processes. Modeling activities are focused on addressing the competing goals of reduced fugitive emissions and gas flaring while also reducing crude oil volatility.
- Directed the EERC's associated gas-flaring mitigation activities, aiding industry partners in their efforts to identify technologies to reduce flaring. These efforts led to the creation of the Flaring Solutions Database, a clearinghouse of business and technology solutions that have the potential to utilize gas at the wellhead and reduce flaring.
- Comanaged a Defense Advanced Research Projects Agency (DARPA)-funded project that successfully developed technology to produce drop-in compatible jet fuel for the military from renewable feedstock. Activities included planning work activities, developing and executing a risk-based project management plan, coordinating activities of five project partners to meet project goals, and communicating with the DARPA project manager.
- Managed the scale-up and design of a 300-barrel/day renewable fuel pilot plant capable of producing specification-compliant jet and diesel fuels from renewable oil feedstock.

Technology Development and Research

- Designed and executed an oil and gas gathering pipeline leak detection demonstration project, resulting in tangible performance improvements for three pipeline operators.
- Conducted a technical and economic assessment of alternative uses for associated gas in an effort to reduce the amount of gas being flared in the Williston Basin. Technologies evaluated included gas-

processing operations to recover natural gas liquids, the use of rich gas in internal combustion engines for transportation and power, and traditional petrochemical unit operations.
- Performed a system-level engineering evaluation of integrated algae production at a coal-fired power plant to assess carbon uptake, emission control requirements, relative scale, and the viability of water and waste heat utilization.
- Designed, fabricated, and operated several fixed-catalyst bed reactor systems to evaluate a variety of thermocatalytic processes to produce renewable fuels and chemicals.
- Conducted testing at coal-fired power plants, and developed control technologies to reduce atmospheric emission of particulate matter, mercury, and other contaminants.

1995–2001: Project Engineer, URS/Radian International, Salt Lake City, Utah (1997–2001), and Milwaukee, Wisconsin (1995–1997).

Process Design, Operation, and Optimization
- Designed groundwater remediation systems to remove BTEX compounds and chlorinated solvents from groundwater. The projects consisted of site evaluation, technology selection and design of several groundwater circulation wells, air sparge/soil vapor extraction treatment systems, and groundwater extraction with air stripper treatment technology. Design aspects included mass balance calculations, equipment design (pumps, pipe sizing, blowers, filters, etc.), equipment selection and specification, bid/construction specifications, and design drawing development.
- Performed start-up and long-term operations for a variety of groundwater remediation systems. Responsibilities included troubleshooting equipment/system malfunctions, process optimization, writing operations and maintenance manuals, establishing performance verification criteria, defining operational cost, and directing technicians' work.
- Conducted detailed reviews of industrial wastewater treatment systems to identify alternative treatment technologies, process optimizations, cost-saving measures, water reuse and zero discharge alternatives, and regulatory considerations.

Construction Oversight
- Provided on-site quality control oversight for several construction projects consisting of mechanical equipment installation, instrumentation and process control, building and road construction, excavation, and underground utility installation. Daily responsibilities included evaluating work for conformance with construction drawings and specifications; conducting progress meetings; coordinating subcontractor work activities; and facilitating communication between the design firm, client, and subcontractors.

Project Management
- Served as project manager for several large projects that were completed successfully. Activities included developing cost proposals, managing budget and schedule, equipment and subcontractor acquisition, and maintaining effective communication with the client.

1994–1995: Process Engineer, Archer Daniels Midland, Clinton, Iowa.

Plant Operation
- Supervised operations and personnel at a wet corn mill oil extraction and refining plant. Tasks consisted of prioritizing work activities, scheduling maintenance and repairing process equipment, reviewing quality control, and extensive system troubleshooting and failure analysis.

Publications and Presentations
Has authored or coauthored numerous publications.

ROBERT C.L. KLENNER
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Principal Areas of Expertise
Mr. Klenner's principal areas of interest and expertise include reservoir modeling, petrophysics, unconventional resources, petroleum geology, geothermal energy, machine learning, and commercialization of research and development (R&D).

Qualifications
M.S., Geology, University of North Dakota, 2012.
B.S., Geology, University of North Dakota, 2009.

Professional Experience
August 2018–Present: Principal Geoscientist, EERC, UND. Mr. Klenner leads geological evaluations for CO_2 EOR, CO_2 storage, and unconventional hydrocarbon recovery projects and geomodeling and simulation efforts.

July 2017–July 2018: Senior Geoscientist, Baker Hughes, a GE Company, Oklahoma City, Oklahoma. Mr. Klenner's responsibilities included the following:
- Served as Reservoir Analytics Program Leader, including staffing, budgeting, project management, legal, and intellectual property oversight.
- Secured funding internally and externally through proposal writing and presentations for CO_2 EOR and unconventional hydrocarbon recovery R&D.
- Oversaw a team of dotted-line reports, including machine learning scientists, software developers, reservoir engineers, and geoscientists to execute CO_2 EOR and unconventional oil and gas projects.
- Worked closely with unconventional oil and gas operators to understand the requirements for the creation of minimal viable products to optimize production through completion optimization, including back-end analytics and front-end UI/UX (user interface/user experience) design.
- Commercialized research activities internally through product lines and externally through ventures.

July 2014–June 2017: Lead Geoscientist, GE Global Research, Oklahoma City, Oklahoma. Mr. Klenner's responsibilities included the following:
- Led projects and direction for unconventional and CO_2 EOR reservoir analytics development.
- Created analytics that led to production optimization via steam-assisted gravity drainage (SAGD) steam allocation and CO_2 EOR.
- Built or consumed 3-D geomodels for technology feasibility studies of conventional and unconventional reservoirs, including the Athabasca Oil Sands, Anadarko Basin (conventional and unconventional), and "sandbox" models to understand alternative fracturing techniques or fluids.
- Participated in activities for company strategy, business development, and joint venture opportunities in reservoir modeling, analytics, and simulation.

March 2012–June 2014: Research Geoscientist, EERC, UND. Mr. Klenner's responsibilities included the following:

- Compiled and managed data for petrophysical analysis, geomodeling, and reservoir simulation for CO_2 EOR and storage resource evaluations.
- Characterized conventional and unconventional reservoirs through data analysis and core descriptions for formations in the Powder River and Williston Basins.
- Developed basin- and field-level geomodels for the Powder River and Williston Basins.

June 2011–March 2012: Geophysicist Intern, Calpine Corporation, Houston, Texas. Mr. Klenner's responsibilities included the following:

- Analyzed well surveys and log data to understand steam injection in a large-scale geothermal reservoir.
- Compiled a database and built a geomodel from lithological and steam fracture data for 700+ wells.

May 2009–March 2012: Graduate Research Assistant, Petroleum Research, Energy, and Entrepreneurship Center, UND. Mr. Klenner's work focused on petrophysical core analysis to determine thermal rock properties for the Williston Basin and North American craton. Specific responsibilities included thermal conductivity measurements, spectral gamma ray measurements, data management, and quality control. Petrophysical results were analyzed and presented in scientific journals and at conferences.

Publications and Presentations

Has authored or coauthored publications in the fields of CO_2 storage, EOR, geothermal energy, and machine learning solutions for upstream oil and gas.

APPENDIX C

BUDGET NOTES

BUDGET NOTES

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 http://und.edu/finance-operations (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.

Equipment Rental Fees: Various field equipment, compressors, and other field staging equipment will be necessary at the pilot gas injection site during the test(s). The budgeted amount is based on past history.

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.

Subcontracts: PNX logging efforts are budgeted for potential use for the pilot test(s). The budgeted costs are based on previous history.

Communications: Telephone, cell phone, and fax line charges are included in the F&A cost; however, direct project costs may include line charges at remote locations, long-distance telephone charges, postage, and other data or document transportation costs that can be directly identified to a project. Estimated costs are based on prior experience with similar projects.

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.

Food: Expenditures for project partner meetings where the primary purpose is dissemination of technical information may include the cost of food. The project will not be charged for any costs exceeding the applicable GSA meal rate. EERC employees in attendance will not receive per diem reimbursement for meals that are paid by project funds. The estimated cost is based on the number and location of project partner meetings.

Professional Development: Fees are for memberships in technical areas directly related to work on this project. Technical journals and newsletters received as a result of a membership are used throughout the development and execution of the project by the research team.

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.

Graphics 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.

Shop and operations recharge fees cover specific expenses related to the pilot plant and the required expertise of individuals who perform related activities. Fees may be incurred in the pilot plant, at remote locations, or in EERC laboratories whenever these particular skills are required. The rate includes such items as specialized safety training, personal safety items, fall protection harnesses and respirators, CPR certification, annual physicals, protective clothing/eyewear, research by-product disposal, equipment repairs, equipment safety

inspections, and labor to direct these activities. The estimated cost is based on the number of hours budgeted for this group of individuals.
Engineering services recharge fees cover specific expenses related to retaining qualified and certified design and engineering personnel. The rate includes training to enhance skill sets and maintain certifications using Webinars and workshops. The rate also includes specialized safety training and related physicals. The estimated cost is based on the number of hours budgeted for this group of individuals.

Software solutions services recharge fees are for development of customized Web sites and interfaces, software applications development, data and financial management systems for comprehensive reporting and predictive analysis tools, and custom integration with existing systems. The estimated cost is based on prior experience with similar projects.

Freight expenditures generally occur for outgoing items and field sample shipments.

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.