



November 1, 2012

Ms. Karlene Fine
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. 2013-0058 Entitled “Bakken Production Optimization Program” in
Response to the North Dakota Industrial Commission Oil and Gas Research Program
Solicitation

The Energy & Environmental Research Center (EERC) is pleased to propose a research program designed to encourage and promote the use of new technologies that have a positive economic and environmental impact on oil and gas exploration and production in North Dakota.

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
Associate Director for Research

Dr. Gerald H. Groenewold, Director
Energy & Environmental Research Center

JAH/sah

Enclosures

c/enc: Brent Brannan, OGRC

Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Program Title: Bakken Production Optimization Program

Applicant: Energy & Environmental Research Center

Principal Investigator: John A. Harju

Date of Application: November 1, 2012

Amount of Request: \$3,000,000

Total Amt. of Proposed Program: \$6,000,000

Duration of Program: 3 Years

Point of Contact (POC): John A. Harju

POC Telephone: (701) 777-5157

POC E-Mail Address: jharju@undeerc.org

POC Address:

15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

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ABSTRACT

Objective:

The Energy & Environmental Research Center (EERC) proposes to lead a subscription-based consortium, including the North Dakota Industrial Commission (NDIC) Oil and Gas Research Council (OGRC) and Bakken producers, with the goal of improving the efficient utilization of resources (fuel, water, land, etc.) and production of salable hydrocarbons at wellsites, thus achieving significant cost containment strategies for participating producers and improved economic output of each well. Bakken oil has been demonstrated to be expensive to recover. This program will investigate new technologies and approaches to decrease recovery costs in an environmentally sound manner.

Expected Results:

The results of the proposed work will increase well productivity and economic output of North Dakota's oil and gas resources, decrease environmental impacts of wellsite operations, and reduce demand for infrastructure construction and maintenance. Specific results may include a) less truck traffic, resulting in decreased diesel emissions, road dust, and spills; b) decreased road maintenance costs; c) decreased wastewater production, disposal costs, and reduced use of freshwater resources; d) reduced flaring and cleaner flares; e) reduced land use impacts; f) increased royalties and tax revenue from harnessed associated gas and natural gas liquid streams; and g) increased revenue from added product streams, captured earlier in the well life cycle.

Duration:

The duration of the NDIC portion of the proposed program will be 3 years (January 1, 2013, to December 31, 2015). Three years of OGRC support is critical to initiate this program. Following the initiation phase, the program is expected to continue with commercial participation only but will still benefit North Dakota and will support NDIC goals.

Total Program Cost:

The total cost of the program during the first three, OGRC-funded, years is \$6,000,000. The amount requested from OGRC is \$1,000,000 annually for 3 years (\$3,000,000 total). Cofunding in the form of cash and in-kind contributions will be provided by a consortium of Bakken producers.

Participants:

Several companies have provided letters regarding their intention to participate, while several others are still contemplating participation. Participants committed to date include the EERC, NDIC OGRC, and Marathon Oil Company, Whiting Petroleum Corporation, and Continental Resources. Additional commercial partner participation will be solicited throughout the duration of the program.

PROJECT DESCRIPTION

The Energy & Environmental Research Center (EERC) proposes a robust program with the goal of improving the overall efficiency of wellsite activities, thus achieving significant cost containment strategies for participating producers and improved economic output of each well. This goal will be achieved by investigating new and novel methods of integrating various wellsite functions, capitalizing on available on-site resources in lieu of “importing” fuels to accomplish the same functions, and recycling various drilling, well treatment, and completion fluids. Bakken oil has been demonstrated to be expensive to recover. This program will investigate new technologies and approaches to decreasing recovery costs in an environmentally sound manner.

Tasks within this program will be dictated by project participants but will likely include (but will not be limited to) combined natural gas liquid (NGL) recovery and natural gas utilization on-site for power; on-site wastewater and hydraulic fracturing fluid recycling to minimize transportation and disposal costs; drilling, workover, and completion rig repowering to enable utilization of associated gas available on-site or nearby; and many other possible optimizations that will be identified by industry participants over the course of the program. Wellsite opportunities that integrate power- and water-related aspects during drilling/workover/completion activities, water transport and utilization, and fuel utilization to achieve cost containment (and thus maximization of economic output of wellsites) will be explored. Means of improving the efficiency of handling and disposing of drilling and production wastes, including naturally occurring radioactive materials (NORM) will also be explored. Wellsite logistics (such as efficiency opportunities arising from simultaneous drilling, completion, flow testing, and production operations on a single wellsite) will also be included, as will any optimizations that result in a net reduction of truck traffic in and out of the wellsite.

The program is designed to accommodate scope growth as new partners come on board and as the needs of industry continue to evolve. Ongoing discussions with several potential partners have led the EERC to focus on four major areas in the first year of the program:

- Site logistics
- Hydrocarbon utilization
- Water management
- Process optimization and systems failure analysis

This program is being proposed as a broad, subscription-based consortium of industry and government interests that will address problems affecting oil production in North Dakota and improve the operational efficiency of wellsite activities of any or all participants. This model has a demonstrated track record of success in other programs at the EERC. Several companies have provided letters regarding their intention to participate, while several others are still contemplating participation. Participants committed to date include the EERC, NDIC OGRC, and Marathon Oil Company, Whiting Petroleum Corporation, and Continental Resources. Letters of commitment received as of the time of submission are presented in Appendix B. It is anticipated that additional industry partners will come on board in successive years as the utility of this program is demonstrated. Additional industry partners may include additional producers, oil field service providers, wireline services, water treatment providers, gas processors and NGL recovery technology providers.

Goals and Objectives:

The goal of the proposed program is to explore wellsite optimization approaches that have potential to reduce wellsite costs, improve wellsite production, reduce wellsite development and operation impacts to surrounding land owners, and decrease demands on surrounding infrastructure and water sources. This goal will be achieved by executing a responsive, dynamic, industry-driven program targeted to address critical issues faced by the oil and gas industry. Specific objectives of this program will include the following:

1. Initiate the program with high-priority tasks driven by industry input.
2. Share results of completed tasks among consortium members for rapid adoption of new methods, and maximum economic and environmental impact within North Dakota.
3. Investigate additional optimization opportunities with existing and potential consortium members.
4. Provide public outreach to public and private organizations.

Methodology:

This program will be organized initially along four technical topic areas (more may be added as industry requests dictate) and one program support area. These topic areas are offered here only as

examples of expected priorities held by industry. During any given year, tasks will not necessarily populate each of these topic areas.

Site Logistics – These are individual tasks focused on improvements of vehicle flow and workflow on well pads, space-saving on well pads, combined functionality of currently independent work units on well pads, improved well pad materials, and/or improved means of handling drilling and production wastes, including those that may contain NORM.

Hydrocarbon Utilization – These are individual tasks focused on improving the production of oil, gas, or NGLs from wellsites. Tasks may include investigations of on-site utilization of natural gas prior to gathering, for example.

Water Management – These are individual tasks focused on technologies to limit demand for freshwater, decrease wastewater production, and reduce water/wastewater trucking to and from the wellsite.

Process Optimization and Systems Failure Analysis – These are individual tasks focused on analysis of failures at the wellsite that affect production efficiency. For example, this activity may include corrosion studies of well casing and well pump components or investigating improved wellbore techniques.

Program Management – This will involve integration of intertopic tasks, industry-driven public outreach to communities and local stakeholders (such as educational meetings currently being facilitated by OGRC staff), program reporting, collaboration with industry and OGRC, recruiting of new members, and strategic studies.

The program will begin with a kickoff meeting for industry partners and OGRC. At this meeting, initial research task proposals will be offered and the group will prioritize those tasks to pursue during the first year. Detailed scopes of work, time lines, and budgets will be developed for each selected task. A similar exercise will be conducted at least annually during each year of the program. Nonproprietary results of tasks selected by the consortium will be shared among all members of the consortium and reported to OGRC.

The EERC will be responsible for coordination and execution of tasks with assistance provided by members of the consortium. The EERC will also be responsible for dissemination of results and for briefing NDIC OGRC upon request. Further, the EERC will present yearly progress summaries at OGRC meetings.

A significant effort within the program will focus on looking for integration opportunities between individual tasks. It is envisioned that many tasks will occupy adjacent spaces physically, operationally, and financially. Every opportunity to combine tasks will be sought for the sake of overall program efficiency.

Anticipated Results:

This program will provide the oil and gas industry with a valuable tool to address key issues related to wellsite optimization. The results of the proposed work will likely increase well productivity and economic output, decrease environmental impacts of wellsite operations, and reduce demand for infrastructure construction and maintenance. The overall outcomes of this program may include the following:

Environmental:

- Less truck traffic, resulting in decreased diesel emissions, decreased road damage and subsequent maintenance, and decreased road dust, decreased incidence of spills.
- Less wastewater production and reduced demand for freshwater supplies.
- Less flaring and reduced emissions from flares.
- Potential for smaller well pads.

Economic:

- Increased royalties from harnessed associated gas and NGL streams.
- Increased tax base from harnessed associated gas and NGL streams.
- Increased profits from added product streams, engaged earlier in the well life cycle.
- Decreased road maintenance costs.
- Decreased costs for water and wastewater hauling and disposal.

Facilities, Resources, and Techniques to Be Used:

The EERC possesses a number of laboratory facilities that may be employed at will by individual tasks within this program. The Applied Geology Laboratory conducts geomechanical, petrographic, geochemical, and customized core sample-related experiments designed to solve targeted problems in the oil and gas industry. The Natural Materials Analytical Research Laboratory includes x-ray diffraction, x-ray fluorescence, and scanning electron microscopy systems. The Analytical Research Laboratory conducts wet-chemistry and advanced trace elemental analyses. Mobile chemistry laboratories owned by the EERC may be employed to conduct quick-turnaround analyses on the wellsite when wellsite logistics permit. The EERC's experienced staff encompasses the geology, chemistry, physics, and engineering disciplines. These laboratories have decades of experience and have been instrumental in conducting a broad range of research to support previous Bakken research activities and reservoir condition experimental work, including work on proppants, drilling and completion fluids, and wastewaters.

The EERC also possesses a rich-gas test facility capable of simulating Bakken-like associated gas mixtures to specification. Several engine test stands have been installed at the EERC to investigate running engines off synthesis gas (syngas) or natural gas mixtures. The EERC possesses additional real estate to accommodate additional facilities and test apparatuses as the program requires.

Environmental and Economic Impacts While Program Is Under Way:

Since the proposed program will involve an extensive assortment of research activities, the environmental and economic impacts will also be wide-ranging. It is difficult to predict specific environmental impacts evident while the program is under way because the proposed program is designed to accommodate a variety of task specifics. Environmental and economic impacts will necessarily be managed and mitigated within each task scope. Individual task proposals to the program will formally address environmental and economic impacts in writing. Task evaluation will include an assessment of how the task manages economic impacts or mitigates environmental impacts prior to funding.

Ultimate Technological and Economic Impacts:

Ultimately, this program has the potential to provide broad and far-reaching technical and economic impacts. Each research task undertaken will have the potential to bolster oil and gas industry operations by improving operational logistics, improving resource recovery, decreasing costs, reducing environmental impacts, and increasing revenue. Bakken oil has been demonstrated to be expensive to recover. This program will investigate numerous ways to decrease recovery costs.

Why the Program Is Needed:

Only very recently have the larger producers in the Bakken declared an end to the boom phase of Bakken development, and called instead for a rapid shift to a cost containment mode. This shift opens the door to a coordinated, multiparticipant program to address issues common to all producers while maximizing economic benefit to North Dakota, oil and gas producers, and mineral rights holders. A coordinated program approach will improve wellsite profits and productivity by employing shared results from focused investigations on methods of optimizing wellsite activities. Although all producers go about wellsite activities with unique procedures, the overarching requirements and results of these activities are common to all producers. It is in this space that this program will focus its efforts to improve wellsite economics.

STANDARDS OF SUCCESS

Success will be measured in the program's ability to address the oil and gas industry's critical issues, ultimately resulting in more efficient resource development and cost savings. Results will be readily accessible through EERC reports provided to OGRC for inclusion on its Web site. Technical publications will be approved by, and targeted at, the oil and gas industry. Success will also be measured by timely achievement of program milestones (deliverables shown below) and the development and conduct of individual tasks that meet the goals of the program.

Deliverables:

1. Annual program steering meeting summaries provided to OGRC.
2. Quarterly reports to OGRC highlighting results of ongoing research as well as anticipated research activities.

3. Topical reports summarizing the results of each completed task.
4. A final report to OGRC summarizing program achievements and challenges. This report will also include a financial synopsis and review input from the program partners.
5. Partner-approved publications at technical conferences.

The value to North Dakota is improved economic output of the entire Williston Basin wellsite population, especially in the newly developed Bakken play. According to Ryder Scott,¹ As a rule of thumb, finding-and-development (F&D) costs combined with lease operating expenses (LOEs) account for roughly 90%–95% of the full-cycle costs over the life of an oil or gas asset. This is expanded in a January 2011 North Dakota State University study² that found expenditures as summarized in Table 1. These figures illustrate that the largest gains in cost containment can be realized in the exploration and production phases of oil and gas recovery in North Dakota. This is the focus of this proposed program.

Table 1. Summary of 2009 North Dakota Oil & Gas Expenditures

| | 2009 North Dakota Expenditures, \$ millions | % of Total Listed Expenses |
|-----------------------------------|---------------------------------------------|----------------------------|
| Exploration | | |
| In-State Exploration and Drilling | 2453.4 | 65% |
| Production | | |
| Extraction | 598 | 16% |
| General Business | 386 | 10% |
| Processing | | |
| Transportation | 69 | 3% |
| Producing Activities | 242 | 6% |

BACKGROUND/QUALIFICATIONS

Personnel:

Resumes of key personnel are provided in Appendix A. John Harju, EERC Associate Director of Research, will serve as program manager. Jay Almlie, EERC Senior Research Manager, and Chad Wocken, EERC Senior Research Manager, will serve as co-principal investigators and will guide technical aspects and integration of the program. Other key EERC personnel will include Beth Kurz, Senior Research Manager (water management); Jim Sorensen, Senior Research Manager (senior exploration and production leader); Tom Doll, Senior Petroleum Engineer (senior advisor); Brad Stevens, P.E., Research Engineer (civil engineering); and Dan Stepan, Research Engineer (water and wastewater management).

¹ Ryder Scott Company LP., 2011, Bakken: making waves from Bismarck to Brisbane: Reservoir Solutions, vol. 14, no. 1, p. 3.

² Bangsund, D., and Leistriz, F., 2011, Petroleum industry's economic contribution to North Dakota in 2009: Agribusiness and Applied Economics Report No. 676S, January 2011.

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 and the Plains CO₂ Reduction (PCOR) Partnership. The Center for Oil and Gas is a specialized technical group focusing on design and implementation of new approaches to the exploration, development, and production of oil and gas. Background data collection, design and implementation of pilot studies, full-scale demonstrations, and analysis of results are typical activities conducted in the Center for Oil and Gas. Related projects conducted in the past include studies focused on the Williston, Powder River, Denver–Julesburg, and Alberta Basins. Within the Center for Oil and Gas, the EERC has also completed studies on enhanced utilization of ungathered associated gas and drill rigs powered with associated gas.

The EERC is currently leading one of the world's largest programs dedicated to developing and demonstrating technologies to reduce CO₂ emissions to the atmosphere from large-scale sources, including substantial efforts on enhanced oil recovery. The EERC's PCOR Partnership is one of seven regional partnerships operating under the U.S. Department of Energy's (DOE's) National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program. Since its inception in 2003, the PCOR Partnership has received the support of over 100 private and public sector members who have provided data, guidance, financial resources, and practical experience with carbon capture, utilization, and storage. The PCOR Partnership region includes all or part of nine states and four Canadian provinces.

MANAGEMENT

The EERC manages approximately 265 contracts a year, with a total of more than 1225 clients in 51 countries and all 50 states. Best practices are provided to EERC project managers and clients with regard to fund accounting, budget reporting, contract milestone tracking, and contract services. The deliverables of this proposal will be incorporated into a contract agreement ensuring timely accomplishment of milestones. Progress reports will be prepared on a quarterly basis and will serve as a

means of evaluating the program with respect to budget, schedule, and technical achievement. The evaluation points are identified in the Gantt chart in Figure 1.

John Harju, EERC Associate Director for Research, will oversee the entire program. He will be responsible for understanding technical details, budget details, schedule details, and environmental and economic implications of each task investigated. Further, he will be responsible for communicating program and task progress to NDIC OGRC on a regular basis via reports and in-person meetings with NDIC OGRC. As program manager, he will be responsible for program coordination, guidance, and supervision to ensure consistent progress and adherence to budget and schedule constraints and for maintaining the integrity of the program.

Individual tasks within the program will each be led by an assigned task manager, who will be responsible for technical execution, task budget management, task schedule maintenance, and task report preparation. Funding for approved tasks will be isolated from the available program funds, and each task will be tracked independently as a facet of the program.

TIMETABLE

This program is proposed as a 3-year program beginning on January 1, 2013, and ending on December 31, 2015. Program direction and annual task funding distribution will be determined at the beginning of each year during steering meetings attended by consortium members. OGRC will be briefed upon request or at its semiannual meetings. Additional timetable detail will be developed by consortium members during the first kickoff meeting. Figure 1 summarizes the program timetable.

| Task | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | | |
|----------------------------------------------------------------|--------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|--------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|--------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|---|
| | M-1 | M-2 | M-3 | M-4 | M-5 | M-6 | M-7 | M-8 | M-9 | M-10 | M-11 | M-12 | M-1 | M-2 | M-3 | M-4 | M-5 | M-6 | M-7 | M-8 | M-9 | M-10 | M-11 | M-12 | M-1 | M-2 | M-3 | M-4 | M-5 | M-6 | M-7 | M-8 | M-9 | M-10 | M-11 | M-12 | |
| Program Management | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ |
| Semi-Annual OGRC Briefings | | | | | | ★ | | | | | | | | | | | | | ★ | | | | | | | | | | | | | | | | | | ★ |
| Consortium Steering Meetings | ★ | | | | | | | | | | | | ★ | | | | | | | | | | | | ★ | | | | | | | | | | | | |
| Outreach Activities | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ |
| Year 1 Tasks (Detail Developed During Kickoff Meeting) | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year 2 Tasks (Detail Developed During Annual Steering Meeting) | | | | | | | | | | | | | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | | | | | | | | | | | | | |
| Year 3 Tasks (Detail Developed During Annual Steering Meeting) | | | | | | | | | | | | | | | | | | | | | | | | | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ |

Figure 1. Preliminary program timetable.

BUDGET

The total cost of the program during the first three, OGRC-funded years is \$6,000,000. The amount requested from the OGRC is \$1,000,000 annually for 3 years (\$3,000,000 total). Cofunding in the form of cash and in-kind contributions will be provided by a consortium of Bakken producers. Several companies have committed to participate, including Marathon Oil Company, Whiting Petroleum Corporation, and Continental Resources. Several others are still contemplating participation, including Statoil, Hess, Oxy, and QEP. Letters of commitment received from initial consortium members, at the time of submission, can be found in Appendix B. The EERC is in discussions with additional consortium members and hopes to bring them on board in the next 2–3 months. The EERC may access available funds from DOE to provide any shortfalls in industry funds to achieve the minimum non-NDIC 50% cost-share requirement for the first year of the program, if needed.

The budget shown in Table 2 is based on previous EERC experience with large programs like the one proposed. Detailed budgets for approved tasks will be developed as new tasks are identified. Budget justification can be found in Appendix C. If less NDIC funding is available, adjustments to scope and/or participating companies' contributions may need to be adjusted.

Table 2. Three-Year Budget Breakdown

| Project Associated Expense | NDIC Share | Industry Share | Total Program |
|----------------------------------------|-------------------|-----------------------|----------------------|
| Total Labor | \$ 2,433,292 | \$ 2,498,342 | \$ 4,931,634 |
| Travel | \$ 104,522 | \$ 237,590 | \$ 342,112 |
| Supplies | \$ 179,545 | \$ 191,200 | \$ 370,745 |
| Communication | \$ 4,349 | \$ 2,957 | \$ 7,306 |
| Printing & Duplicating | \$ 8,940 | \$ 8,640 | \$ 17,580 |
| Food | \$ 7,599 | \$ 8,640 | \$ 16,239 |
| Operating Fees & Svcs | | | |
| Natural Materials Analytical Res. Lab. | \$ 109,145 | \$ - | \$ 109,145 |
| Analytical Research Laboratory | \$ 7,155 | \$ - | \$ 7,155 |
| Particulate Analysis | \$ 39,421 | \$ - | \$ 39,421 |
| Graphics Support | \$ 24,165 | \$ 25,949 | \$ 50,114 |
| Shop and Operations Support | \$ 37,271 | \$ 26,682 | \$ 63,953 |
| Remote Sampling Trailer | \$ 44,596 | \$ - | \$ 44,596 |
| Total Project Cost | \$ 3,000,000 | \$ 3,000,000 | \$ 6,000,000 |

CONFIDENTIAL INFORMATION

There is no confidential information included in this proposal. It is likely that confidential information will be involved in, or created during, the execution of program tasks. In such cases, confidential information outlined within the task proposal and after reaching agreement with the consortium, will be withheld from public disclosure. The intent of the program is to make as much information publicly and widely available as possible.

PATENTS/RIGHTS TO TECHNICAL DATA

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

STATUS OF ONGOING PROJECTS (IF ANY)

1. G-015-030 “Plains CO₂ Reduction Partnership Program – Phase III”; OGRC funding \$500,000; Total project cost \$135,731,052. Status: Project ongoing. Phase III is a 10-year project running from October 1, 2007, to September 30, 2017. The activities for Phase III of the PCOR Partnership include two large-volume carbon dioxide (CO₂) storage demonstration tests and the characterization of oil fields in North Dakota for CO₂ enhanced oil recovery (EOR). Public outreach activities to support the demonstrations located in Fort Nelson, British Columbia, and Bell Creek, Montana, are under way.
2. G-026-060 “Enhanced Bakken Recovery Research Program”; OGRC funding \$450,000; Total project cost \$1,350,000; Status: Project ongoing. The EERC is in the midst of Task 1 – Detailed Characterization of Selected Bakken Sites and has initiated some of the Task 2 – Examination of the Use of CO₂ for Storage and EOR in the Bakken Formation activities.
3. G-024-057 “Demonstration of Gas-Powered Drilling Operations for Economically Challenged Wellhead Gas and Evaluation of Complementary Platforms”; OGRC funding \$750,000; Total project cost \$1,900,000; Status: Project ongoing. Activity 1 – Lean-Gas Demonstration, Activity 2 – Bakken Gas Research, and Activity 4 – End-Use Technology Study are complete. Activity 3 – Rich-Gas Demonstration is nearly complete. This project is scheduled to be completed by March 31, 2013.

APPENDIX A
RESUMES OF KEY PERSONNEL



JOHN A. HARJU

Associate Director for Research

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) 777-5157, Fax: (701) 777-5181, E-Mail: jharju@undeerc.org

Principal Areas of Expertise

Mr. Harju's principal areas of interest and expertise include carbon sequestration, enhanced oil recovery, 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.

2011–Present: Associate Director for Research. Mr. Harju oversees the activities of a team of scientists and engineers focused on research, development, demonstration, and commercialization of energy and environmental technologies. Strategic energy and environmental issues include zero-emission coal utilization; CO₂ capture and sequestration; energy and water sustainability; hydrogen and fuel cells; advanced air emission control technologies, emphasizing SO_x, NO_x, air toxics, fine particulate, and mercury control; renewable energy; wind energy; water management; flood prevention; global climate change; waste utilization; energy efficiency; and contaminant cleanup.

2003–2011: Associate Director for Research. Mr. Harju's responsibilities included developing and administering programs involving petroleum technology, natural resource evaluations, water management and contamination cleanup and building industry–government–academic teams to carry out research, development, demonstration, and commercialization of energy and environmental products and 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.

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, \$8MM 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

National Petroleum Council

Interstate Oil & Gas Compact Commission, Chairman, Energy Resources, Research and
Technology Committee

U.S. Department of Energy Unconventional Resources Technology Advisory Committee

Rocky Mountain Association of Geologists

Publications and Presentations

Has authored and coauthored numerous publications.



JAY C. ALMLIE

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Phone: (701) 777-5260, Fax: (701) 777-5181, E-Mail: jalmlie@undeerc.org

Principal Areas of Expertise

Mr. Almlie's principal areas of interest and expertise include hydrogen production technologies, particle capture in electrostatic precipitators, mercury control technologies, thermal control systems, water-processing systems, and environmental control and life support systems.

Qualifications

B.S., Mechanical Engineering, and B.S., Engineering Management, University of North Dakota, 1995.

Proficient in the use of LabView, AutoCad, Autodesk Inventor, MS Excel, MS Project, MathCAD, Rockwell Software RSLogix, and RSView Studio.

Professional Experience

2009–Present: Senior Research Manager, Environmental Technologies, EERC, UND. Mr. Almlie's responsibilities include supervision and direction of a diverse group of approximately 30 researchers focused on emission control technology development and hydrogen generation technology development. Mr. Almlie is responsible for technical, managerial, and business development aspects of this work. Mr. Almlie has managed several successful multimillion-dollar projects during his tenure in this position.

2006–2009: Research Manager, Environmental Technologies, EERC, UND. Mr. Almlie's responsibilities included supervising a team of researchers focused on mercury emission control, particulate matter emission control, and hydrogen production. Mr. Almlie was also involved technically in projects in each of these areas.

2001–2006: Research Engineer, Environmental Technologies, EERC, UND. Mr. Almlie's responsibilities included projects involving mercury control, particulate matter emission control, and emission control for diesel systems.

2000–2001: Lead Mechanical Engineer, Water Systems, International Space Station Habitability Outfitting, and Deputy Project Manager, International Space Station Galley, Lockheed Martin Space Operations Company, Houston, Texas. Mr. Almlie's responsibilities included supervision of the Galley Potable Water System and Waste and Hygiene Compartment Crew Hygiene System design teams, development of system architecture and component specs, design of water system engineering development units, and thermal and fluid mechanics analysis and testing on water systems. He was also responsible for customer interfacing, team integration, project direction and cost/schedule estimates for both projects, including planning and analyzing project

performance, monitoring progress, and developing “to-completion” cost estimates within an earned value system.

1995–2000: Mechanical Engineer, Hernandez Engineering, Inc. Mr. Almlie’s responsibilities included involvement in several projects:

- Lead mechanical engineer for a potential Space Shuttle thermal control system upgrade, including performing thermal design, analysis, and test functions and serving as project manager for the \$1 million research project. This was one of 10 projects identified by the National Research Council as leading contenders to extend the life of the Space Shuttle fleet.
- Lead mechanical engineer for water recovery systems, including performing mechanical system design and analysis functions; designing, testing, and analyzing a potable water tank/radiation protection system for a crew habitat vehicle; and performing project management functions.
- Test engineer for the International Space Station Active Thermal Control System (ATCS), including conducting fluid line, fluid flow balance, and thermal/vacuum testing on ISS Active Thermal Control components and participating in Analysis and Integration Team activities to ensure ISS Thermal Control System function on-orbit.

1994–1995: Research Assistant, School of Engineering and Mines, UND. Mr. Almlie’s responsibilities included computational fluid mechanics model generation for combustion applications using Fluent software.

Summer 1994: Engineering Intern, Orbital Sciences Corporation, Inc., Dulles, Virginia. Mr. Almlie’s responsibilities included performing launch vehicle dynamic separation analyses, designing payload separation system components, performing multiple stress/strain analyses on payload carrier structures using COSMOS/M finite element analysis software.

1993–1994: Teaching Assistant, School of Engineering and Mines, UND. Mr. Almlie’s responsibilities included assisting with thermodynamics, heat and mass transfer, and fluid mechanics courses.

1991–1993: Mechanical Engineering Cooperative Education Program Participant, Eagle Engineering, Inc., Houston, Texas. Mr. Almlie’s responsibilities included authoring a satellite ground tracking code, coauthoring a separation simulation code, serving as a company representative on launch vehicle mission status reviews, and performing payload fairing separation analysis for the Pegasus rocket.

Publications and Presentations

Has coauthored several professional publications.

Patents and Technology Disclosures

Advanced Particulate Matter Control Apparatus and Methods, US8,092,768, January 2012.

Water Membrane Evaporator

Radiation Shield Water Tank: Microgravity Water Tank with Capillary Air/Liquid Separation
Used for Radiation Shielding



CHAD A. WOCKEN

Senior Research Manager

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) 777-5273, Fax: (701) 777-5181, E-Mail: cwocken@undeerc.org

Principal Areas of Expertise

Mr. Wocken's principal areas of research include developing alternative energy technologies and renewable fuels. Currently, he is leading projects focused on developing and advancing alternative energy systems at the bench, lab, and pilot scale for technologies associated with renewable liquid fuels, hydrogen production and purification, and gasification. 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: E.I.T. Chemical Engineering, 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: Senior Research Manager (2001–2009, Research Engineer), EERC, UND.

Project/Program Management

- Co-managed 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 renewable fuel technology capable of producing specification-compliant jet and diesel fuels from renewable oil feedstock. The pilot-scale facility to be collocated with a petroleum refinery will have the capability of processing up to 300 barrels/day of renewable oil feedstock.

Technology Development and Research

- 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 and corn 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.



BETHANY A. KURZ

Senior Research Manager

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 is a Senior Research Manager within the Energy & Environmental Research Center's (EERC's) Oil and Gas Research Group. Ms. Kurz's principal areas of interest and expertise include the evaluation and demonstration of unconventional water supply sources for the oil and gas industry, development and testing of proppants for hydraulic fracturing of unconventional reservoirs, evaluation of guar gum substitutes for use in hydraulic fracturing fluid systems, and produced water management. Additional experience includes hydrologic modeling, flood and drought mitigation, and remediation of contaminants in soil and water.

Qualifications

M.S. (Summa Cum Laude), Geology, University of North Dakota, Grand Forks, ND, 1998.

B.S. (Summa Cum Laude), Geochemistry, Bridgewater State University, Bridgewater, MA, 1995.

Professional Experience

2011–Present: Senior Research Manager, Oil and Gas Research Program, EERC, UND. Ms. Kurz oversees several of the EERC's analytical research laboratories that focus on classical and advanced wet chemistry analyses; petrochemical and geomechanical evaluation of rocks and soils; and mineralogical assessment of natural materials using optical microscopy, x-ray fluorescence, x-ray diffraction, and scanning electron microscopy. Additional activities include the development and testing of proppants for use in hydraulic fracturing, evaluation of water supply sources for the oil and gas industry, produced water management, and characterization of geologic media for carbon storage.

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, development of strategies to address future water shortages, 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 and Wind Energy 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. She also assisted in research related to wind energy development in the region, with an emphasis on wind resource

assessment, education and outreach, database development, and windsmith training curriculum development.

1997–1998: Research Assistant, Water Quality Laboratory, Department of Geology and Geological Engineering, UND. Ms. Kurz’s duties included the operation and maintenance of a water quality laboratory containing several analytical instruments, including an ion chromatograph, inductively coupled plasma emission spectrometer, total organic carbon analyzer, and several ion selective electrodes.

1996–1998: Research Assistant, Department of Geology and Geological Engineering, UND. Ms. Kurz’activities included the investigation of groundwater nitrate reduction by organic and inorganic constituents of soil, sediment, and water.

1995–1996: Teaching Assistant, Department of Geology and Geological Engineering, UND. Ms. Kurz’s responsibilities included preparing and teaching laboratory classes in the field of geology, as well as organizing and conducting geology-related field trips.

Related Skills and Experience

Computer: ArcGIS, SWAT, ERMapper, ERDAS Imagine, MS Word, Excel, Access, Project Manager, Power Point, Corel Draw, Surfer, MODFLOW, WATSUTRA, Aquifer Test.

Analytical: Ion chromatograph, total organic carbon analyzer, inductively coupled plasma emission spectrometer, gas chromatograph, ion-selective electrodes, laser-induced breakdown spectroscopy (LIBS).

Field Work: Monitoring well and in situ microcosm (ISM) installation; soil vapor extraction system (SVE) design, installation, and optimization; groundwater sampling, analysis, and monitoring; wind-monitoring system installation; and wind data collection and analysis.

Presentations and Publications

Has authored or coauthored numerous professional publications



JAMES A. SORENSEN
Senior Research Manager

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) 777-5287, Fax: (701) 777-5181, E-Mail: jsorensen@undeerc.org

Principal Areas of Expertise

Mr. Sorensen's principal areas of interest and expertise include geologic storage of carbon dioxide, petroleum geology, subsurface transport and fate of organic and inorganic contaminants associated with the natural gas industry, research program management, technical report writing, and presentations.

Education

B.S., Geology, University of North Dakota, 1991.
Postgraduate course work in Hydrogeology, Advanced Geomorphology, Groundwater Monitoring and Remediation, Geochemistry, and Contaminant Hydrogeology, 1993–1995.

Professional Experience

1999–Present: Senior Research Manager, EERC, UND. Mr. Sorensen currently serves as manager and coprincipal investigator for several research programs, including the Plains CO₂ Reduction (PCOR) Partnership, a multiyear, multimillion-dollar program focused on developing strategies for reducing carbon dioxide emissions in nine states and four Canadian provinces. 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, interacting with clients and industrial contacts, and proposal writing and presentation.

1997–1999: Program Manager, EERC, UND. Mr. Sorensen managed projects on topics that included treatment of produced water, environmental fate of mercury and 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 evaluating the subsurface transport and fate of mercury and natural gas-processing chemicals 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 numerous publications.



DANIEL J. STEPAN

Research Engineer

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

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

Phone (701) 777-5247, Fax (701) 777-5181, E-mail: dstepan@undeerc.org

Principal Areas of Expertise

Mr. Stepan's principal areas of interest and expertise include industrial wastewater treatment, groundwater and soil remediation, and pilot- and bench-scale treatability testing.

Education

M.E., Sanitary Engineering/Water Resource Management, University of North Dakota, 1988.

B.S., Civil Engineering, University of North Dakota, 1985.

Professional Experience

2012–Present: Research Engineer, EERC, UND. Mr. Stepan's responsibilities include working on a multidisciplinary array of wastewater treatment and water remediation research projects at the EERC. He helps to coordinate the Northern Great Plains Water Consortium[®] and is actively pursuing research projects in the treatment and reuse of oil field waters, enhanced anaerobic treatment of dairy manure, biomass gasification wastewater treatment, water resource assessments for power generation, and assessment and treatment of nontraditional water supplies. Mr. Stepan develops new business opportunities and pursues new clients, prepares proposals for research projects, directs and carries out laboratory experiments, designs and fabricates pilot and field biological test systems, writes project reports and papers, and gives paper presentations related to water, wastewater, and anaerobic digestion.

1999–2012: Senior Research Manager, Water Resource Management and Wastewater Treatment, EERC, UND. Mr. Stepan's responsibilities included coordination of the Northern Great Plains Water Consortium and management of multidisciplinary wastewater treatment and remediation research projects. Research activities included treatment and reuse of oil field waters, enhanced anaerobic treatment of dairy manure, biomass gasification wastewater treatment, water resource assessments for power generation, and assessment and treatment of nontraditional water supplies.

1993–1999: Research Manager, Remediation, EERC, UND. Mr. Stepan's responsibilities included evaluation of thermal, chemical, and physical remediation technologies for the removal of mercury from soils and the development and field demonstration of remediation technologies, including soil vapor extraction, bioventing, and ex situ groundwater remediation to address subsurface contamination at natural gas processing facilities.

1988–1992: Research Engineer/Project Manager, EERC, UND. Mr. Stepan was responsible for the overall technical direction of wastewater treatability testing programs. Principal Investigator responsible for design, construction, operation, data handling and data reduction, and reporting

for bench- and pilot-scale treatability test programs involving coal processing wastewaters. Treatability program operations and processes included solvent extraction, steam stripping, conventional activated sludge, two-stage activated sludge, coupled nitrification/denitrification activated sludge, rotating biological contactors, cooling towers, wet air oxidation, activated carbon adsorption, ion exchange, ultrafiltration, ozonation, and chemical precipitation.

1987–1988: Engineering Technician, Energy and Mineral Research Center, UND.

1985–1987: Graduate Research Assistant, Department of Civil Engineering, UND. Mr. Stepan was responsible for construction, maintenance, and data reduction for bench-scale activated sludge systems.

1980–1983: Quality Control Technician (summers), Superwood Corporation, Duluth, Minnesota.

1974–1978: U.S. Navy. Aviation jet engine maintenance technician and test cell operator, both ashore and aboard the USS Nimitz. Honorably discharged as Second Class Petty Officer.

Professional Memberships

American Society of Civil Engineers
American Water Works Association
Water Environment Federation

Publications and Presentations

Has authored or coauthored numerous publications.

APPENDIX B
LETTERS OF COMMITMENT

Marathon Oil Company
3172 Highway 22 North
Dickinson, ND 58601
Telephone 701.456.7500
Fax 701.456.7525



October 31, 2012

Mr. John Harju
Associate Director for Research
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Dear John:

Project Entitled "Bakken Production Optimization Program"

This letter is in response to your request for participation in the proposed Energy & Environmental Research Center (EERC)-led effort entitled "Bakken Production Optimization Program." We feel this is an excellent program that will be of significant benefit to North Dakota's oil and gas industry. The study will provide important information to producers, technology providers, and gas processors by 1) exploring the spectrum of technologies and strategies that may optimize Bakken production, 2) facilitating the adaptation of those technologies and strategies under the unique challenges posed by Bakken operations, and 3) establishing the operating and market conditions necessary for their viability. In addition, the program will provide high visibility, high-impact education and outreach to key stakeholders across the region, relating the positive efforts and outcomes of North Dakota's oil and gas producers.

We understand that the EERC is pursuing core funding for this project through the North Dakota Industrial Commission (NDIC) Oil & Gas Research Council, the U.S. Department of Energy, and several other producers. Marathon can commit to supporting the project by providing data, expertise, facilities, and the participation of our experienced staff. In addition, Marathon will commit to providing cash cost share of up to \$200,000 per year for up to 3 years, as this program has many synergies with our interests in the Williston Basin's Bakken play. Marathon's commitment is contingent on the award of adequate matching funds from NDIC's Oil & Gas Research Program and other producers and the negotiation of a mutually acceptable scope of work and attendant contractual terms with all applicable partners.

We are looking forward to participating in this program. Any questions regarding Marathon's involvement in the project may be directed to me by phone at (701) 456-7501 or by e-mail at tjkovacevich@marathonoil.com.

Sincerely,

A handwritten signature in black ink, appearing to read "Terry Kovacevich", written over a horizontal line.

Terry Kovacevich
Bakken Asset Manager



October 30, 2012

Mr. John Harju
Associate Director for Research
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Dear John:

Subject: Project Entitled "Bakken Production Optimization Program"

This letter is in response to your request for participation in the proposed Energy & Environmental Research Center (EERC)-led effort entitled "Bakken Production Optimization Program." We feel this is an excellent program that will be of significant benefit to North Dakota's oil and gas industry. The study will provide important information to producers, technology providers, and gas processors by 1) exploring the spectrum of technologies and strategies that may optimize Bakken production, 2) facilitating the adaptation of those technologies and strategies under the unique challenges posed by Bakken operations, and 3) establishing the operating and market conditions necessary for their viability. In addition, the program will provide high visibility, high-impact education and outreach to key stakeholders across the region, relating the positive efforts and outcomes of North Dakota's oil and gas producers.

We understand that the EERC is pursuing core funding for this project through the North Dakota Industrial Commission (NDIC) Oil & Gas Research Council, the U.S. Department of Energy, and several other producers. Whiting can commit to supporting the project by providing data, expertise, facilities, and the participation of our experienced staff. In addition, Whiting will commit to providing cash cost share of \$200,000 per year for up to 3 years, as this program has many synergies with our interests in the Williston Basin's Bakken play. Whiting's commitment is contingent on the award of adequate matching funds from NDIC's Oil & Gas Research Program and other producers and the negotiation of a mutually acceptable scope of work and attendant contractual terms with all applicable partners.

We are looking forward to participating in this program. Any questions regarding Whiting's involvement in the project may be directed to me by phone at (303) 803-5465 or by e-mail at jack.ekstrom@whiting.com.

Sincerely,

Jack Ekstrom

*Whiting Petroleum Corporation
and its wholly owned subsidiary
Whiting Oil and Gas Corporation*



October 29, 2012

Mr. John Harju
Associate Director for Research
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Dear John:

Subject: Project Entitled "Bakken Production Optimization Program"

This letter is in response to your request for participation in the proposed Energy & Environmental Research Center (EERC)-led effort entitled "Bakken Production Optimization Program." We feel this is an excellent program that will be of significant benefit to North Dakota's oil and gas industry. The study will provide important information to producers, technology providers, and gas processors by 1) exploring the spectrum of technologies and strategies that may optimize Bakken production, 2) facilitating the adaptation of those technologies and strategies under the unique challenges posed by Bakken operations, and 3) establishing the operating and market conditions necessary for their viability. In addition, the program will provide high visibility, high-impact education and outreach to key stakeholders across the region, relating the positive efforts and outcomes of North Dakota's oil and gas producers.

We understand that the EERC is pursuing core funding for this project through the North Dakota Industrial Commission (NDIC) Oil & Gas Research Council, the U.S. Department of Energy, and several other producers. Continental Resources can commit to supporting the project by providing data, expertise, facilities, and the participation of our experienced staff. In addition, Continental Resources will commit to providing cash cost share of \$200,000 per year for up to 3 years, as this program has many synergies with our interests in the Williston Basin's Bakken play. Continental Resources's commitment is contingent on the award of adequate matching funds from NDIC's Oil & Gas Research Program and other producers and the negotiation of a mutually acceptable scope of work and attendant contractual terms with all applicable partners.



We are looking forward to participating in this program. Any questions regarding Continental Resources's involvement in the project may be directed to me by phone at (405) 234-9283 or by e-mail at brad.aman@clr.com.

Sincerely,

A handwritten signature in black ink that reads "Bradley A. Aman".

Bradley A. Aman, PE
Vice President, Northern Region Production



HESS CORPORATION
3015 16th ST. SW
Minot, ND 58701

October 24, 2012

Mr. John Harju
Associate Director for Research
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Dear John:

Subject: Project Entitled "Bakken Production Optimization Program"

Hess Corporation ("Hess") has reviewed your request for a contribution to the Energy & Environmental Research Center's (EERC) study titled "Bakken Production Optimization Program." While we appreciate the work of the EERC and recognize that this study will cover topics that are of great interest to the oil and gas industry in North Dakota, Hess is unable to make a contribution at this time.

As a member of the North Dakota community, we are always seeking to contribute to projects with strategic goals that are aligned with our social responsibility and business goals. In order to more effectively do that, we are working to improve our internal business processes to systematically identify and evaluate those opportunities on an annual basis as a part of our budgeting process. Unfortunately, we have already finalized our budget for 2013 and so we are unable to consider a contribution to your study in 2012 or 2013. We invite EERC to contact Hess again in the second quarter of 2013 so that we can evaluate the program to determine if we would be able to make a contribution to the study in 2014.

Hess values its relationships in North Dakota and the work of the EERC. We look forward to hearing from you next year so that we can evaluate the possibility of future participation in your study.

Regards,


Steve McNally
General Manager North Dakota
Hess Corporation

APPENDIX C
BUDGET JUSTIFICATION

BUDGET JUSTIFICATION

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

BACKGROUND

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

INTELLECTUAL PROPERTY

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

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only. The project manager may incur and allocate allowable project costs among the funding sources for this scope of work in accordance with Office of Management and Budget (OMB) Circular A-21.

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.

Labor: Estimated labor includes direct salaries and fringe benefits. Salary estimates are based on the scope of work and prior experience on projects of similar scope. Salary costs incurred are based on direct hourly effort on the project. Fringe benefits consist of two components which are budgeted as 56% of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the U.S. 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. The following table represents a breakdown by labor category and hours for technical staff for the proposed effort.

| Labor Categories | Labor Hrs |
|-------------------------------|------------------|
| Research Scientists/Engineers | 30,796 |
| Research Technicians | 2,441 |
| Senior Management | 1,171 |
| Technology Dev. Mechanics | 9,000 |
| Technical Support Services | 2,475 |
| | 45,883 |

Travel: Travel expenses include estimates for travel to 2–3 conferences each year, regional industry-driven public outreach activities, and travel to Bismarck to brief OGRC regularly on program status. Travel costs are estimated and paid in accordance with OMB Circular A-21, Section 53, 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, etc., are based on historical costs. Miscellaneous travel costs may include taxis, parking fees, Internet charges, long-distance phone, copies, faxes, shipping, and postage.

Equipment: If equipment (value of \$5000 or more) is budgeted, it is discussed in the text of the proposal and/or identified more specifically in the accompanying budget detail.

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: Not applicable.

Professional Fees: Not applicable.

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.

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 operation recharge fees are for expenses directly associated with the operation of the pilot plant, including safety training, personal safety items (protective eyeglasses, boots, gloves), and annual physicals for pilot plant personnel. The estimated cost is based on the estimated hours for pilot plant personnel.

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

Facilities and Administrative Cost: The facilities and administrative rate of 49% (indirect cost rate) included in this proposal is approved by the U.S. Department of Health and Human Services. Facilities and administrative cost is calculated on modified total direct costs (MTDCs). MTDCs are 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. The facilities and administrative rate has been applied to each line item presented in the budget table.