

**PROGRAM TO DETERMINE THE UNIQUENESS OF THREE FORKS BENCH
RESERVES, DETERMINE OPTIMAL WELL DENSITY IN THE BAKKEN POOL, AND
OPTIMIZE BAKKEN PRODUCTION (BAKKEN PRODUCTION OPTIMIZATION
PROGRAM)**

**QUARTERLY PROGRESS REPORT
January – March 2015**

BACKGROUND

The goal of the Bakken Production Optimization Program (BPOP) being conducted by the Energy & Environmental Research Center (EERC) in close coordination with Continental Resources, Inc. (Continental) and several of the Williston Basin's other premier operating companies is to simultaneously improve Bakken system oil recovery while reducing its environmental footprint. The program is investigating new technologies and approaches to simultaneously increase the understanding of potential petroleum reserves in the Bakken–Three Forks system and decrease recovery costs in an environmentally sound manner.

The anticipated outcomes of BPOP are to 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 will include a) a greater understanding of Bakken–Three Forks reservoirs and subsequent significant increases to estimates of recoverable hydrocarbons; b) less truck traffic, resulting in decreased diesel emissions, road dust, and spills; c) reduced road maintenance costs, wastewater production, disposal costs, and freshwater use; d) reduced land use impacts; and e) increased revenue for the state, royalty owners, and operators from added product streams captured earlier in the well life cycle.

The following quarterly report summarizes the program activities from January through March 2015.

ACCOMPLISHMENTS DURING REPORTING PERIOD

Continental leads Phases I–IV. The EERC leads activities in Phase V.

Phases I–IV (Continental)

- Continental is working on the final report on the Hawkinson Project. Results, analyses, and conclusions from studies undertaken in the various phases were collected and organized to be included in this report.

Phase I – Drilling Wells in the Hawkinson Unit Located in Sec. 22 and 27, 147N-96W

- Results of the final proppant embedment tests were delivered.

Phase II – Completion Operations of Eleven (11) New Wells

- ESG delivered its final report in mid-March. Continental is presently evaluating and integrating the conclusions into the project's evaluation.

Phase III – Reservoir Engineering

- Continental completed the integration of results from various studies into a single cohesive interpretation of the reservoir. The comprehensive update report includes the resulting reservoir interpretation.

Phase IV – Expansion Applications via 3-D Seismic

- Interpretation of the 3-D seismic survey's many attributes, derived from Geotrace BE processing, was completed.

Phase V – Optimization of Wellsite Operations

Hydrocarbon Utilization (EERC Task 1)

Flaring Reduction

- North Dakota Petroleum Council (NDPC) Flaring Task Force/database development.
 - The EERC continued to work with technology/service providers capable of utilizing associated gas upstream of traditional gas-gathering and processing infrastructure and gathered information describing their remote capture offerings. To date, more than 60 companies have provided company and technical information to the database.
 - ◆ Companies with remote capture technology can submit information to the database at www.undeerc.org/Flaring_Solutions/.
 - ◆ Companies looking for more information about remote capture technologies can view all of the information contained in the database at www.undeerc.org/Flaring_Solutions/Search.aspx.
 - The EERC continued to review technical data provided by vendors and is supporting vendors' ongoing efforts to develop offerings that address the challenges leading to gas flaring.
 - The EERC continued to work with producers and vendors to identify opportunities for demonstration projects that have the potential to improve gas utilization and reduce the risk of implementing new technologies and strategies. Work continues to assess the relative impact individual technologies can have on gas use, thereby decreasing the fraction of flared gas in North Dakota.

- An EERC representative spoke on natural gas flaring at the NDPC Workshop in Bismarck, North Dakota, on January 14, 2015. The presentation described conditions that lead to flaring in North Dakota, updated statistics on the size and frequency of flaring, and provided an overview of different remote capture technologies. A copy of the presentation can be found on the members-only Web site at www.undeerc.org/Bakken/Optimization/.

Crude Oil Characterization

- The EERC spoke to the North Dakota Industrial Commission (NDIC) on January 9 about ongoing crude oil characterization work being conducted by the EERC for the U.S. Department of Energy (DOE).
- In an effort separate from this Program but closely related to it, the EERC is supporting a DOE-funded study focused on characterizing tight oil properties relative to safe storage and transport. Work conducted within the project, considered a problem definition exercise, included providing text and technical expertise in the preparation of a comprehensive literature review of sampling and analytical methods and tight oil analytical data. The report, summarizing publicly available information on crude oil properties, was released on March 24, 2015, and is available at http://energy.sandia.gov/wp/wp-content/gallery/uploads/dlm_uploads/SAND2015-18233.pdf. Additionally, work has begun on preparation of a crude oil characterization plan that will outline the tasks needed to collect the information necessary to evaluate crude oil properties and their relevance to the likelihood and severity of a combustion incident resulting from transport. A document describing the crude oil characterization plan is expected to be completed during the next reporting period. Although this work is not being funded by BPOP, the EERC will continue to report on this work here because of its close connection to work done within the Program.

Minimization of Fugitive Associated Gas Emissions

- No work was conducted during the reporting period.

Investigation of Rich Gas for EOR (enhanced oil recovery)

- Work complete.

Waste Management (EERC Task 2)

NORM Waste Disposal

- In January 2015, EERC personnel presented testimony at each of three public hearings arranged by the North Dakota Department of Health (NDDH) to receive public comment on proposed new rules regarding in-state TENORM (technologically enhanced naturally occurring radioactive material) waste disposal. Public hearings

were held in Williston, Bismarck, and Fargo. The EERC's testimony focused on the challenges of in-field compliance using the proposed rules. These comments were echoed by others representing industry. A copy of the testimony provided to NDDH can be found at www.undeerc.org/Bakken/Optimization. A sample of media coverage of the public hearings can be found at www.valleynewslive.com/home/headlines/TENORM-Meeting-A-Rocky-Debate-289522771.html.

- EERC staff continued to consult with the NDPC NORM Task Force and individual Program member companies as they responded to NDDH on the proposed rules in February.
- EERC staff attended the NORM North America conference in Houston, Texas, in March 2015. This is the premier conference discussing the evolving nature of NORM regulations in the United States, and this year's conference included a presentation by NDDH. Many other states are looking toward North Dakota for guidance on this topic. Therefore, several good discussions were held between EERC staff, NDDH staff, and other stakeholders across the nation.

Wellsite Waste Assessment

- No activity occurred during this reporting period. It was determined that several other Program efforts should be prioritized ahead of this item, although it may be revisited this year.

Water Management (EERC Task 3)

Bakken Water Opportunities Assessment

Activities this past quarter focused on incorporating additional data and information into the draft Bakken water management report and on generating predictions of future freshwater use and produced water generation within the Bakken play. The key information incorporated in the report includes the following:

- Data from the NDIC Department of Mineral Resources were summarized regarding the fluid volumes and proppant mass used to stimulate every Bakken well from 2004 to January 2015, as well as the lateral length and number of stages for those wells.
- A summary of various leak detection measures for saltwater pipelines.
- Additional information from partners on freshwater needs for well maintenance (brine dilution) within the Williston Basin.
- Summary-level data obtained from the North Dakota State Water Commission on the number of brine disposal wells and total injection volumes for each year from 2000 to 2014.

- A summary of potential Bakken produced water recycling and reuse scenarios that may have potential for case-by-case utilization.

Site Logistics (EERC Task 4)

- No activities were conducted under this task during this quarter.

Process Optimization and System Failure Analysis (EERC Task 5)

- No activities were conducted under this task during this quarter.

Waste Minimization and Utilization (EERC Task 6)

Drill Cuttings Disposal and Reuse Options

- The EERC completed a white paper on drill cuttings disposal options applicable to North Dakota. A copy of this white paper has been posted to www.undeerc.org/Bakken/Optimization. However, it should be noted that this only a guidance tool for use within the Program. It is meant to advise members on the future of drill cuttings disposal in North Dakota and is not in publishable form.

Spill Remediation (EERC Task 7)

Spill Remediation Science

- EERC staff have continued their involvement with the NDPC Saltwater Spill Task Force, led by BPOP members Oasis Petroleum and Continental Resources, to provide technical documents that establish best practices for mitigating brine spills. Based on input from the spill task force, EERC staff, with contributions from several experts, drafted an educational document termed the Spills Cleanup Primer. The Primer is an expansion of the spills and reclamation fact sheets and will be used to educate industry, landowners, legislators, regulators, and the general public. An electronic copy of this document can be downloaded at www.undeerc.org/Bakken/Optimization.
- The spill remediation fact sheet has been revised to include additional content suggested by the Saltwater Spill Task Force and is now available for distribution. This fact sheet is part of the BakkenSMART suite of fact sheets that cover a variety of headline topics from the Bakken oil play. The updated fact sheet can be downloaded at www.undeerc.org/Bakken/Optimization.
- The EERC, in partnership with North Dakota State University's Range Science and Soil Science programs, has defined an approach for scientific evaluation/comparison and demonstration of several spill remediation techniques and several land reclamation techniques. This approach continues to be discussed with industry partners and others who may be willing to fund a demonstration site defined in the plan.

- Based on recommendation from the spills task force, the EERC will modify the previously drafted Best Practices Guide into a document that will serve more as a “field guide.” The first draft of this document was previously made available at www.undeerc.org/Bakken/Optimization. That draft is still available but will be extensively modified with the assistance of the NDPC Saltwater Spills Task Force.

Pipeline and Facility Leak Detection

- The EERC completed a white paper on available leak detection technologies for liquid hydrocarbons, saline water, and gaseous hydrocarbons. A copy of this white paper has been posted to www.undeerc.org/Bakken/Optimization. However, it should be noted that this is only a guidance tool for use within the Program. It is meant to advise members on the state of the art in leak detection technology and is not in publishable form.

Land Reclamation (EERC Task 8)

Optimization of Land Reclamation Practices

- There are no new activities to report in this quarter beyond the highlighted activities in the previous section.

Program Management and Development

- An EERC representative spoke at a meeting of the North Dakota Environmental Peer Group in Sidney, Montana, on March 26, 2015. The presentation included an overview of BPOP research areas and a summary of specific activities related to flaring and crude oil volatility. A copy of the presentation can be found on the members-only Web site at www.undeerc.org/Bakken/Optimization/.
- The members-only Web site was updated to post new documents, including the two topical white papers mentioned previously in this quarterly report, the testimony provided by EERC staff at the NDDH public hearings on TENORM waste disposal, and the spills primer mentioned previously in this quarterly report.
- The first edition of a new quarterly BPOP newsletter was sent via e-mail to all Program members in January. This newsletter was well-received. It provides insight on several program topics in a manner more readable than demanded by the formal reporting style of the NDIC quarterly reports. The next edition of this quarterly was prepared in March and is set for release in early April.
- The Program announced its next semiannual Program update meeting, set for April 14 and 15 at the EERC. This will be a members-only meeting that encourages open dialogue about the most pressing issues facing all members of the consortium. The meeting will be split into two half-day sessions beginning with lunch on the first day, meeting through the afternoon, and continuing through a hosted evening social and

dinner; the second day will consist of a morning meeting, concluding with lunch. Key elements of this meeting will include the following:

- A comprehensive update from Continental Resources on the Hawkinson project.
- An update on the active and still-evolving North Dakota Legislative session and its impacts on the Program and our membership.
- Updates on the EERC’s progress on a number of program products, including these:
 - ◆ An updated Bakken Water Opportunities Assessment, which will be released to the members prior to the meeting.
 - ◆ Updates on NDDH public hearings on proposed new TENORM waste disposal regulations and a summary of the EERC’s efforts and our guidance to members in response to these proposed regulations.
 - ◆ Updates on the EERC’s engagement with the NDPC Saltwater Spills Task Force to create educational materials on the science of spill remediation and land reclamation. Program members within this task force are directing our efforts.
 - ◆ A number of program products have been generated and will be provided to attendees of the meeting. These products are also always available to members at the members-only Web site.
 - ◆ Updates on EERC efforts focused on flaring reduction technologies.
- EERC representatives attended and participated in several committee hearings of the North Dakota State Legislature as well as dialogue with committee members regarding legislation of direct relevance to BPOP activities. Specific topics addressed within these hearings and meetings included pipeline construction and monitoring, leaks and spills, reclamation, recycling and long-term liability, enhanced oil recovery, and Department of Mineral Resources duties and authorities.

MEMBERSHIP AND FINANCIAL INFORMATION

BPOP is sponsored by the NDIC Oil and Gas Research Council, Continental, and a consortium of Bakken producers and service companies. Table 1 presents the current budget for this program. Continental’s expected in-kind contribution over the project duration is \$106,030,000. The anticipated contribution from other industry sponsors is \$750,000 a year for a total of \$2,250,000. Payments have been received from all members for Years 1 and 2 totaling \$1,500,000. It is expected that equal payments will be provided by the industry partners in Year 3. During this quarter, the EERC received Year 2 payment from SM Energy Company. The EERC will continue to seek broader industry participation.

Expenses to date by funding source are listed in Table 2.

Table 1. BPOP – Expected Budget

Sponsors	Y1	Y2	Y3	Total
NDIC Share – Cash*	\$3,134,512	\$3,204,944	\$2,215,044	\$8,554,500
Industry Share – Cash (confirmed participation)	\$750,000	\$750,000	\$750,000	\$2,250,000
Continental Share – In-Kind	\$40,989,233	\$40,989,233	\$24,051,534	\$106,030,000
Total	\$44,873,745	\$44,944,177	\$27,016,578	\$116,834,500

* Includes \$6.26M subcontract to Continental.

Table 2. BPOP – Expenses to Date

	Funding Source		Total
	NDIC	Industry	
EERC	\$998,695	\$882,429	\$1,881,124
Continental – Subcontract*	\$4,235,000		\$4,235,000
Continental – In-Kind**		\$98,943,012	\$98,943,012
Total	\$5,233,695	\$99,825,441	\$105,059,136

* Invoiced to the EERC.

** Reported to the EERC.

FUTURE ACTIVITIES

The planned activities for the next quarter include the following:

Phases I–IV (Continental)

- A final presentation of the results of the Hawkinson Project was presented at the BPOP meeting hosted by the EERC in Grand Forks, North Dakota, on April 14. Continental is now finalizing the written report and will make it available by the end of May 2015.

Phase I – Drilling Wells in the Hawkinson Unit

- A final presentation of the results of the Hawkinson Project was presented at the BPOP meeting hosted by the EERC in Grand Forks, North Dakota, on April 14. Continental is now finalizing the written report and will make it available by the end of May 2015.

Phase II – Completion Operations of Eleven (11) New Wells

- A final presentation of the results of the Hawkinson Project was presented at the BPOP meeting hosted by the EERC in Grand Forks, North Dakota, on April 14. Continental is now finalizing the written report and will make it available by the end of May 2015.

Phase III – Reservoir Engineering

- A final presentation of the results of the Hawkinson Project was presented at the BPOP meeting hosted by the EERC in Grand Forks, North Dakota, on April 14. Continental is now finalizing the written report and will make it available by the end of May 2015.

Phase IV – Expansion Applications via 3-D Seismic

- A final presentation of the results of the Hawkinson Project was presented at the BPOP meeting hosted by the EERC in Grand Forks, North Dakota, on April 14. Continental is now finalizing the written report and will make it available by the end of May 2015.

Phase V (EERC)

Hydrocarbon Utilization (Task 1)

Flaring Reduction

- Continue working with vendors to identify opportunities to deploy technology and/or services that match the needs of producers in their efforts to improve gas capture and utilization.
- Continue working with industry partners and vendors to identify opportunities to conduct demonstration projects that allow stakeholders the ability to evaluate technologies capable of improving gas use.
- Monitor industry's progress toward meeting the gas capture targets in North Dakota, and continue to assess the technical and economic viability of remote capture use.

Crude Oil Characterization

- Work has begun preparing a crude oil characterization plan that will outline the tasks needed to collect the information necessary to evaluate crude oil properties and their relevance to the likelihood and severity of a combustion incident resulting from transport. A document describing the crude oil characterization plan is expected to be completed during the next reporting period.

Minimization of Fugitive Associated Gas Emissions

- No work is planned.

Investigation of Rich Gas for EOR

- No work is planned.

Waste Management (Task 2)

NORM Waste Disposal

- EERC staff will continue to consult with partners on NORM waste management strategies via the NDPC NORM Task Force. The EERC will continue to provide input as the Task Force guides its members toward compliance with the new regulations that are likely to promulgate later this summer or early this fall.

Wellsite Waste Assessment

- In light of current reprioritization activities within the industry due to dramatic drops in oil prices, no activity is anticipated on this topic during the coming quarter.

Water Management (Task 3)

Bakken Water Opportunities Assessment

- Activities will focus on finalizing the updated Bakken water management practices report, now that additional data and potential reuse scenarios have been incorporated. When complete, this report will be posted to www.undeerc.org/Bakken/Optimization.
- The key findings of the updated Bakken water management report will be presented to members during the next meeting scheduled for April 14 and 15.
- An updated Bakken water fact sheet will be finalized.

Site Logistics (Task 4)

- No activity is currently planned in this area during the first quarter of 2015.

Process Optimization and Systems Failure Analysis (Task 5)

- No activity is currently planned in this area during the first quarter of 2015.

Waste Minimization and Utilization (Task 6)

Drill Cuttings Disposal and Reuse Options

- No activity is currently planned in this area during the first quarter of 2015.

Spill Remediation (Task 7)

Spill Remediation Science

- EERC staff will continue to participate in discussions with the Saltwater Spill Task Force, contributing to overall Task Force objectives and creating technical content as the Task Force attempts to convey that science is being applied to improve spill remediation.
- EERC staff will continue to consult with partners on near-term industry needs regarding current deficiencies in spill remediation and land reclamation methodologies.
- The EERC will distribute fact sheets on spill remediation and land reclamation, as well as the Spills Cleanup Primer for public education efforts.
- The EERC will engage Program membership in discussions regarding the scoping and funding of a spill remediation/land reclamation demonstration site or sites.
- EERC personnel will reinitiate work on the previously drafted Best Practices Guide.

Pipeline and Facility Leak Detection

- It is anticipated that during the coming quarter, the North Dakota legislature may enact funding for an EERC study of improved methods of pipeline construction and monitoring. This will likely result in a concerted effort through the end of the calendar year to complete a comprehensive study on leak detection technologies, leading to demonstrations of new technologies in North Dakota. Program membership will be consulted to help guide study efforts regarding common priorities and will be solicited to support a suite of demonstrations.

Land Reclamation (Task 8)

Optimization of Land Reclamation Practices

- EERC staff will continue participation in Pipeline Reclamation Task Force discussions to determine an appropriate role for BPOP, given the interests of the Task Force and BPOP membership.
- The EERC will distribute fact sheets on spill remediation and land reclamation, as well as the Spills Cleanup Primer for public education efforts.
- The EERC will engage Program membership in discussions regarding the scoping and funding of a spill remediation/land reclamation demonstration site or sites.
- EERC personnel will reinitiate work on the previously drafted Best Practices Guide.

Program Development and Management

- The EERC will continue to promote one-on-one meetings with Program members to directly engage them in Program prioritization.
- The EERC will continue to seek membership from other industry stakeholders for this Program.