



Energy & Environmental Research Center

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www.undeerc.org

August 15, 2025

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

Dear Mr. Kannianen:

Subject: EERC Proposal No. 2025-0160 Entitled "Bakken Production Optimization Program (BPOP) 5.0" 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 continuation of a well-established research program that encourages and promotes the use of new technologies that have a positive economic and environmental impact on oil and gas exploration and production in North Dakota.

The \$100 application fee for this proposal is provided through ACH Transaction No. 292188. 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) 777-5287 or by email at jsorensen@undeerc.org.

Sincerely,

DocuSigned by:

A blue ink signature of Jim Sorensen, written in a cursive style, enclosed within a blue rectangular border.

0671D00C8437443...

James A. Sorensen

Director of Subsurface Research and Development

Approved by:

DocuSigned by:

A blue ink signature of Charles D. Gorecki, written in a cursive style, enclosed within a blue rectangular border.

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Charles D. Gorecki, CEO
Energy & Environmental Research Center

JAS/kal
Attachment

c/att: Erin Stieg, North Dakota Industrial Commission

Oil and Gas Research Program
North Dakota
Industrial Commission

Application

Program Title: Bakken Production Optimization
Program (BPOP) 5.0

Applicant: Energy & Environmental Research
Center

Principal Investigator: James A. Sorensen

Date of Application: August 15, 2025

Amount of Request: \$6,000,000

Total Amt. of Proposed Project: \$12,030,206

Duration of Project: 2 years

Point of Contact (POC): James A. Sorensen

POC Telephone: (701) 777-5287

POC Email Address: jsorensen@undeerc.org

POC Address:

15 North 23rd Street, Stop 9018

Grand Forks, ND 58202-9018

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ABSTRACT

The Energy & Environmental Research Center (EERC) proposes to conduct laboratory, modeling, and field-based research activities using innovative technology to guide the next generation of Bakken production under the Bakken Production Optimization Program (BPOP). From 2021 to 2025, Bakken producers faced headwinds from federal policies clearly meant to stifle growth in oil production, and BPOP provided partners with technical solutions to navigate those headwinds. However, recent changes in federal law meant to drive American energy dominance have resulted in policy tailwinds, including increased financial incentives for qualifying enhanced oil recovery (EOR) projects. BPOP activities will enable partners to take advantage of those anticipated tailwinds. **Objective:** To provide technical tools that optimize oil production and lead to the broad deployment of technologies, including EOR and improved oil recovery, that enable continued sustainable development of North Dakota's vast Bakken resources. **Expected Results:** Maintaining the Bakken as a dominant world class oil play and economic engine for North Dakota. **Duration:** 2 years (September 1, 2025 – August 31, 2027). **Total Program Cost:** The total value of the project is \$12,030,206. This proposal requests \$3,000,000 annually for 2 years (\$6,000,000 total) from the Oil and Gas Research Program (OGRP). The U.S. Department of Energy (DOE) will provide \$4,450,206 of cash cost share, and Chord Energy will provide in-kind contributions (valued at \$380,000) toward a commercial-scale EOR pilot in a Bakken drilling spacing unit (DSU). The EERC anticipates sustained industry engagement in the form of annual partnership fees. Those contributions, reported to the North Dakota Industrial Commission as received, will increase the total value of the program. Based on past participation levels, the budget includes a conservative estimate of \$1,200,000 from annual partnership fees. **Participants:** In addition to OGRP, Chord, and DOE, the EERC anticipates ongoing support from several companies—Devon Energy, XTO Energy (subsidiary of ExxonMobil), and Petro-Hunt L.L.C.—which have supported previous BPOP phases. Additional partners are anticipated to join as the program continues.

PROJECT DESCRIPTION

The Energy & Environmental Research Center (EERC) proposes to provide industry and the state of North Dakota with technical support to drive innovation that facilitates production of the next 5 billion barrels of oil from the Bakken through the development and testing of technologies under the existing and highly successful North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP)-sponsored Bakken Production Optimization Program (BPOP). The EERC proposes a 2-year program of activities—BPOP 5.0—that optimizes petroleum production in North Dakota. BPOP-5.0 is a continuation of the collaborative effort between the state of North Dakota, the petroleum industry, and the U.S. Department of Energy (DOE) to develop solutions to challenges in the Bakken. A summary of accomplishments over the past 11 years of BPOP are provided in Appendix A.

Industry and state stakeholders have expressed a desire to maximize the productivity of wells and drilling spacing units (DSUs), increase the ultimate recovery of oil, and reduce the carbon intensity of Bakken operations. Stakeholders are interested in optimizing and improving primary production throughout the Bakken play, determining how to best move into secondary production through implementation of commercial-scale enhanced oil recovery (EOR) and improved oil recovery (IOR) technologies, reducing flaring and fugitive methane emissions, mitigating well souring, and improving operational efficiencies. Building on lessons learned from BPOP involvement in recent EOR pilots with Liberty Resources, BPOP 5.0 will include participation in a large-scale pilot being conducted by Chord Energy with cost-share from DOE. North Dakota's industry is capturing gas at levels that exceed goals set by the Department of Mineral Resources in 2014. However, the goal to eliminate flaring in North Dakota is yet to be achieved. BPOP research has enabled the creation of new gas capture technology that makes it affordable to capture the remaining flared volumes in North Dakota. BPOP 5.0 intends to continue the flare reduction work by conducting field pilots in the next phase with the support of DOE. The industry is quickly changing, with more economic completion practices, including 3- and +4-mile laterals and wells

that U-bend within DSUs. These approaches decrease the expense of additional wellheads, vertical well casing, and facilities. The EERC's data analytics activities will provide valuable insights for the partners of BPOP in analyzing production from these new developments that help steer the industry and drive investment, especially for underdeveloped areas of the Bakken. Technical advances that result from the proposed activities will serve to support the long-term productivity and economic vitality of Bakken assets, leading to future decades of the Bakken as a world-class oil play and economic engine for North Dakota.

The success of BPOP to date suggests a high likelihood of a significant return on investment by the state and its industry partners. Throughout the first 11 years of the program, the EERC has demonstrated that the strength of BPOP rests in its ability to address a broad range of ever-changing technical priorities. Key topics that will be addressed during the next 2 years of BPOP include the following:

- Moving Bakken EOR from pilot testing to commercial-scale deployment:
 - Working with Chord Energy to perform robust laboratory, modeling, and field injection activities to demonstrate the potential for Bakken EOR under the DOE-funded Bakken CO₂ EOR Field Lab (BCO₂EORFL).
- Pursuing research activities identified as being of high priority based on partner feedback:
 - Benchmarking of lease operating expenses (LOE) across the Bakken.
 - Mitigation of hydrogen sulfide (H₂S) generation in Bakken wells.
 - Basinwide statistical analyses of drilling, completion, refracturing, and production operations using machine learning (ML) and artificial intelligence (AI) techniques.
 - Reservoir characterization using advanced petrophysics, machine learning, and sequence stratigraphy methods to support Tier 2 and Tier 3 acreage development and EOR scheme designs.

- Evaluation of emerging drilling and completion techniques such as the use of J- and/or U-shaped wells, and alternative completion and stimulation technologies to improve and optimize the efficiency of primary production.

Goals and Objectives: The primary goals of the proposed BPOP 5.0 are to 1) provide the state and industry with science-based insight to maintain the economic sustainability of the Bakken play in North Dakota, with an emphasis on guiding industry to the next phase of Bakken play development through commercialization of EOR and application of emerging IOR technologies and 2) provide stakeholders with the knowledge needed to plan and implement innovative development strategies and reduce lease operating expenses that will add value to Bakken Tier 1, 2, and 3 acreages.

Methodology: BPOP 5.0 will span multiple technical topic areas as state and industry priorities dictate. The flexibility of the stakeholder-driven program will provide the ability to address emerging issues as needed. Through BPOP 5.0, the EERC will continue to serve existing and new North Dakota Petroleum Council (NDPC) task force groups established to address challenges to improve oil recovery, optimize production strategies, mitigate reservoir souring, and inform EOR efforts. The EERC is committed to coordinating with other state-funded EOR pilots awarded under the Enhanced Oil Recovery Grant Program, authorized in 2025 by Senate Bill No. 2014, to ensure quality datasets and findings are documented and disseminated. The primary research topic areas are described below.

Bakken Enhanced Oil Recovery: Recent work has highlighted North Dakota’s significant potential of EOR. Successful application of EOR technologies can unlock billions of barrels of untapped oil, generating substantial revenue. Under BPOP 5.0, the EERC will build on insights from previous Bakken EOR pilot studies, simulations, and data analytics to determine a pathway to commercial implementation across the basin. Efforts will include laboratory experiments, modeling, and field activities to be conducted under the DOE-funded BCO₂EORFL, including a cumulative 18-month injection as part of a commercial-scale pilot being conducted by Chord Energy, currently planned for 2026–2027. These efforts will include

cash cofunding from DOE to evaluate the potential to use carbon dioxide (CO₂) for EOR in the Bakken under the BCO₂EORFL.

Bakken Improved Oil Recovery: Resetting the decline curve and increasing Bakken oil production in North Dakota remains a key priority for both industry partners and state sponsors. To support this goal, the EERC will explore multiple avenues aimed at improving oil recovery from existing assets. One area of focus may be the use of artificial gas lift systems, which can improve well productivity by enabling the efficient flow of reservoir fluids to the surface. In addition, the EERC will evaluate innovative refracturing techniques as a cost-effective method to increase production in mature wells.

Benchmarking of Lease Operating Expenses (LOE): Understanding LOE across the Bakken is essential to assess the overall financial health of the play. Using a combination of publicly available and partner provided data, and in close consultation with industry partners, the EERC will conduct an evaluation and comparison of LOE across the Bakken play. Benchmarking will include comparisons of LOE between different acreage tiers, geological settings, well drilling and completion approaches, workover histories, and other key variables. Results of the LOE benchmarking efforts will enable stakeholders to identify areas for improvement in efficiencies and opportunities to strategically cut costs, thereby improving the financial competitiveness of the Bakken as a world class petroleum play.

Innovative Completion Designs and Wellbore Architectures: The EERC will investigate innovative completion designs and wellbore architectures through modeling and simulation, with an emphasis on extended-reach 3- and 4-mile laterals as well as the exploration of nontraditional drilling paths (such as J wells and U wells) to optimize reservoir contact and performance in the Bakken.

Innovative Gas Capture Technologies: The EERC will use field trials at multiple Bakken production sites to determine the technical and economic viability of the Polar Bear[®] gas capture technology, with a goal of demonstrating its commercial application. This activity will include cash cofunding from DOE.

Completion and Production Data Analytics: The EERC will evaluate the influence of completion techniques and operational parameters on well and DSU performance to determine optimal production strategies. This includes assessing geologic context and variables such as well count per DSU, lateral length, spacing, treatment size, and completion type. Leveraging ML and AI, the analysis will uncover DSU-, field-, and basin-wide trends, informing data-driven recommendations for infill (child) well designs, parent well management strategies, and EOR approaches. While previous phases focused on Tier 1 and 2 acreage, BPOP 5.0 will use ML and AI to also assess development potential in Tier 3 areas. The EERC will work with Virginia Tech Applied Research Corporation (VT-ARC) to apply the latest advances in AI/ML technologies and methods to BPOP data analytics activities. These efforts will identify and prioritize the most impactful potential AI/ML application opportunities in the Bakken. The results of these activities will enable stakeholders to optimize a variety of exploration, development, and production aspects of the Bakken play.

H₂S Investigation: H₂S is an undesirable by-product of oil and gas production in some Bakken wells. Previous BPOP research utilized laboratory analysis, data analytics, and reservoir simulations to identify mechanisms of H₂S generation. Building on this foundation, the EERC will integrate geology, geochemistry, data analytics, and completion simulations to refine strategies for identifying, managing, and mitigating the risk of H₂S generation (reservoir souring).

Reservoir Characterization: To support the evaluation of well completions, EOR, and data analytics, the EERC will conduct reservoir quality assessments of the Bakken petroleum system through sequence stratigraphic and advanced petrophysical analyses. The EERC will continue to build the database of petrophysical interpretations of both high-tier (e.g., spectroscopy and nuclear magnetic resonance logs) and common geophysical well-logging data suites. Leveraging insights from our existing ML analysis, petrophysical interpretations will target production drivers for Tier 2 and 3 acreage. This task will also include efforts by the University of North Dakota's Harold Hamm School of Geology and Geological

Engineering to revise Bakken depositional models across the basin using advanced sequence stratigraphy methods.

Facilities, Resources, and Techniques to Be Used: The EERC employs a multidisciplinary staff of about 260 and has 254,000 square feet of state-of-the-art offices, laboratories, and technology demonstration facilities, which enable staff to address a wide variety of research topics. The EERC houses eight analytical laboratories, including staff and equipment dedicated to advanced characterization of rock, wellbore and infrastructure materials, petroleum, and water. These laboratories have decades of experience and have been instrumental in previous Bakken research. The EERC has extensive geologic modeling, reservoir simulation, and data analytics experience and capabilities, including high-end workstation computers and a dedicated high-performance parallel computing cluster.

Environmental and Economic Impacts While Program Is Underway: The breadth of the program means the environmental and economic impacts will be wide-ranging and difficult to predict. However, the first 11 years of the program are evidence of the positive impact the program has had on North Dakota environmental concerns and economics related to Bakken development. Previous BPOP impacts are outlined in Appendix A, and maps are included in Appendix B.

Ultimate Technological and Economic Impacts: Ultimately, BPOP 5.0 will provide broad technical and economic impacts. Each research task will have the potential to bolster oil and gas industry operations by improving resource recovery, decreasing costs, reducing carbon intensity, and increasing revenue. With original oil in place (OOIP) estimates for the Bakken ranging from 300 to 900 billion barrels, the impact of successful EOR and IOR operations alone could extend the lifetime of the play by decades, yielding billions of barrels of incremental oil and billions of dollars of economic impact to North Dakota.

Why the Project Is Needed: The past 11 years of this program resulted in unprecedented cooperation among state and industry partners in addressing headline issues. Multiple program partners have openly stated that the type of cooperation facilitated by this program exists nowhere else in the petroleum

industry. BPOP efforts to date are summarized in Appendix A. It is anticipated that similar progress can be made on critical topics such as EOR, IOR, future resource development strategies, H₂S mitigation, and other topics over the next 2 years.

STANDARDS OF SUCCESS

Success will be measured in the program's ability to address the oil and gas industry's critical issues as identified by OGRP and BPOP partners, ultimately resulting in more efficient resource development and cost savings. Developing options to help ensure the success of the oil and gas industry in North Dakota while conserving the state's resources leads to a strong state economy and the creation of jobs to support all aspects of oil and gas development. Annual meetings with OGRP and BPOP partners will be held as a measure of success to discuss project status and gather feedback and guidance. Success will also be measured by delivery of high-impact products to state and industrial stakeholders.

The current OGRP-approved process of reporting will be employed to deliver results. This program provides partners premium access to reporting of results from activities for a period of 12 months following review by select partners prior to release to the public on the BPOP website. Products will be prepared on specific topics to be determined based on partner guidance. Select products, as determined by BPOP partners, may be released after shorter review periods if early release is deemed to be of greater advantage to the partners. High-level progress updates will be provided in quarterly or biannual reports, in an executive summary format, to OGRP for inclusion on the OGRP website for immediate access by the public. An annual briefing to OGRP will highlight the successes of BPOP and next steps. A final report summarizing program achievements and challenges will be prepared. Presentations at technical conferences and public outreach events will cover pertinent topic areas.

BACKGROUND/QUALIFICATIONS

The EERC is a nonprofit branch of the University of North Dakota. Resumes of key personnel are provided in Appendix C. James Sorensen, Director of Subsurface Research and Development, will serve

as Program Manager. Dr. John Harju, Vice President for Strategic Partnerships, will serve as Senior Program Advisor. Other key EERC personnel will include Bethany Kurz, Director of Subsurface Characterization and Data Analytics; Darren Schmidt, Assistant Director for Energy, Oil and Gas; Dr. Nick Azzolina, Assistant Director for Applied Data Analytics; Dr. Lu Jin, Distinguished Reservoir Engineer; and Matthew Belobraydic, Assistant Director for Geoscience.

MANAGEMENT

The EERC manages over 200 contracts a year, with a total of over 1300 clients in 53 countries. Systems are in place to ensure that projects are managed within budget, schedule, and scope. Mr. Sorensen will oversee the entire program, with assistance in the management of program activities and tasks by Ms. Kurz and Mr. Schmidt. This will involve integration of tasks, program reporting, collaboration with industry and the Oil and Gas Research Council, recruiting of new partners, and strategic studies. The EERC will be responsible for coordination and execution of tasks, with assistance provided by program partners, and will disseminate results. Biannual status reports will be submitted to NDIC and partners 30 days after the end of each calendar quarter to provide highlights of ongoing research and anticipated future activities. A program kickoff meeting will be scheduled for fall 2025 to prioritize research areas with input from the state and industry. At minimum, annual meetings will be scheduled to provide updates on research activities and discuss the direction of future activities. Webinars will be held periodically throughout the period of performance related to subjects within the scope of work.

TIMETABLE

This effort is proposed as a 2-year program (September 1, 2025 – August 31, 2027). Figure 1 summarizes the preliminary program timetable. Additional timetable detail will be developed as the program evolves.

Bakken Production Optimization Program (BPOP) 5.0																								
Task Title	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Task 1.0 – Project Management and Planning	D1 ▼				D2 ▼				D3 ▼				D4 ▼											
Website Maintenance																								
Task 2.0 – Bakken Enhanced Oil Recovery (EOR)																								
Bakken CO ₂ EOR Field Lab – Pilot Support Activities																								
Task 3.0 – Bakken Improved Oil Recovery (IOR)																								
Task 4.0 – Coordination with State Funded EOR Pilots																								
Task 5.0 – Completion & Production Data Analytics																								
Benchmarking of Lease Operating Expenses																								
H ₂ S Investigation																								
Innovative Completion Designs and Wellbore Architectures																								
Task 6.0 – Reservoir Characterization																								
Task 7.0 – Innovative Gas Capture Technologies																								
Polar Bear Technology Deployment and Testing																								
Deliverables																								
D1 – Biannual Progress Report Submitted																								
D2 – Biannual Progress Report Submitted																								
D3 – Biannual Progress Report Submitted																								
D4 – Final Technical Report Submitted																								

Figure 1. Preliminary program timetable.

BUDGET

The total estimated cost for the proposed effort is \$12,030,206. \$6,000,000 is requested from OGRP (\$3,000,000/year). Cost share will include \$3,305,774 cash from DOE (DOE Award No. DE-FE0032514) and \$1,144,432 cash from DOE (DOE Award No. DE-FE0032543). It is estimated that industry partners will provide a minimum of \$1,200,000 in cash cost share. Support from at least five companies is anticipated, including Chord Energy, ConocoPhillips, Devon, XTO Energy, and Petro-Hunt, which all supported BPOP 4.0. This group includes five of the top oil producers in North Dakota, and their operations cover most of the Bakken play area (Appendix B). Chord Energy will provide in-kind cost share at a minimum value of \$380,000. A portion of the budget will be allocated for meals provided as appropriate to support engagement and collaboration. Letters of support and a DOE letter of award for BCO₂EORFL can be found in Appendix D. The budget shown in Table 1 is based on previous EERC experience with the program. Budget notes can be found in Appendix E.

Table 1. Budget Breakdown

Project-Associated Expense	NDIC Share (Cash)	Industry Share (Cash)	DOE Share (Cash & In-Kind)	Total Project Costs
Labor	\$3,564,828	\$734,181	\$1,698,251	\$5,997,260
Travel	\$118,904	\$36,916	\$92,808	\$248,628
Equipment > \$5000	\$0	\$0	\$65,010	\$65,010
Supplies	\$96,992	\$0	\$1,200	\$98,192
Subrecipient – Chord Energy	\$0	\$0	\$1,052,000	\$1,052,000
Subcontractor – Virginia Tech Applied Research Corp	\$25,000	\$0	\$0	\$25,000
Subcontractor – Steffes Corporation	\$0	\$0	\$59,300	\$59,300
Communications	\$713	\$138	\$244	\$1,095
Printing and Duplicating	\$707	\$129	\$610	\$1,446
Food	\$12,168	\$0	\$700	\$12,868
Rents and Leases – Flow Meter	\$0	\$0	\$129,600	\$129,600
Laboratory Fees and Services				
Document Production Service (Graphics, Editing, and Workflow)	\$70,700	\$5,488	\$115,582	\$191,770
Shop and Operations	\$275	\$0	\$12,127	\$12,402
Software Solution Services	\$42,409	\$0	\$11,852	\$54,261
Technical Software Fee	\$0	\$0	\$7,660	\$7,660
Engineering Services Fee	\$0	\$0	\$5,353	\$5,353
Field Safety Fee	\$0	\$0	\$8,511	\$8,511
Geoscience Services Fee	\$47,391	\$17,848	\$21,794	\$87,033
Outside Lab	\$0	\$0	\$39,892	\$39,892
Total Direct Costs	\$3,980,087	\$794,700	\$3,322,494	\$8,097,281
Facilities and Administration	\$2,019,913	\$405,300	\$1,127,712	\$3,552,925
Total Cash Requested	\$6,000,000	\$1,200,000	\$4,450,206	\$11,650,206
In-Kind Cost Share				
Chord Energy	\$0	\$0	\$380,000	\$380,000
Total In-Kind Cost Share	\$0	\$0	\$380,000	\$380,000
Total Project Costs	\$6,000,000	\$1,200,000	\$4,830,206	\$12,030,206

CONFIDENTIAL INFORMATION AND PATENTS/RIGHTS TO TECHNICAL DATA

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

STATUS OF ONGOING PROJECTS

The EERC is currently engaged in seven OGRP-funded projects. These ongoing projects, listed in

Appendix F, are current on all deliverables.

APPENDIX A

BAKKEN PRODUCTION OPTIMIZATION PROGRAM KEY ACCOMPLISHMENTS TO DATE

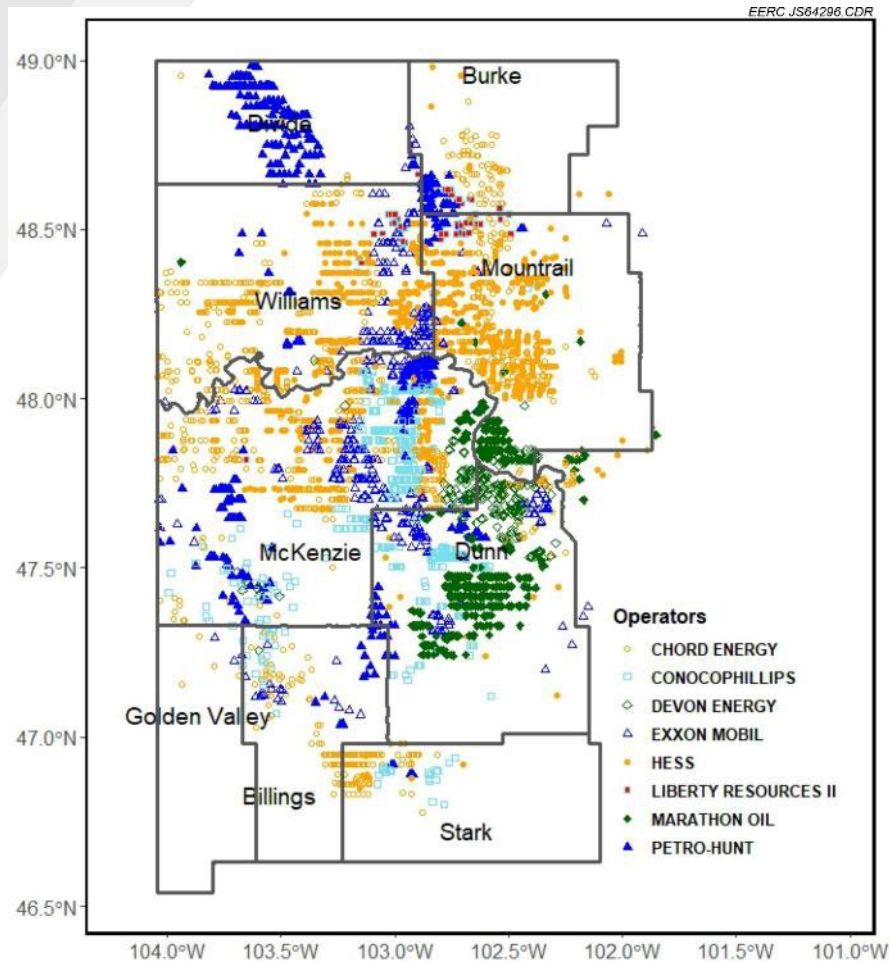


Energy & Environmental Research Center (EERC)

Bakken Production Optimization Program (BPOP) – 12 Years of Accomplishment through Public–Private Partnership

James Sorensen
Director for Subsurface R&D

Thank You to the BPOP 4.0 Partners! (2023-2025)



Map showing geographic distribution of BPOP partner well locations.

Bakken Production Optimization Program (BPOP)

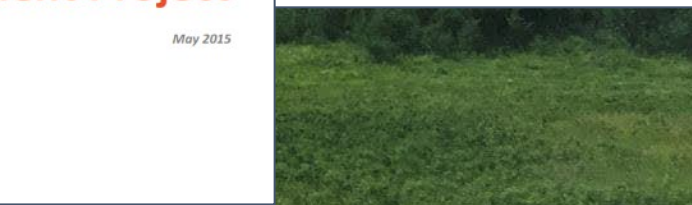
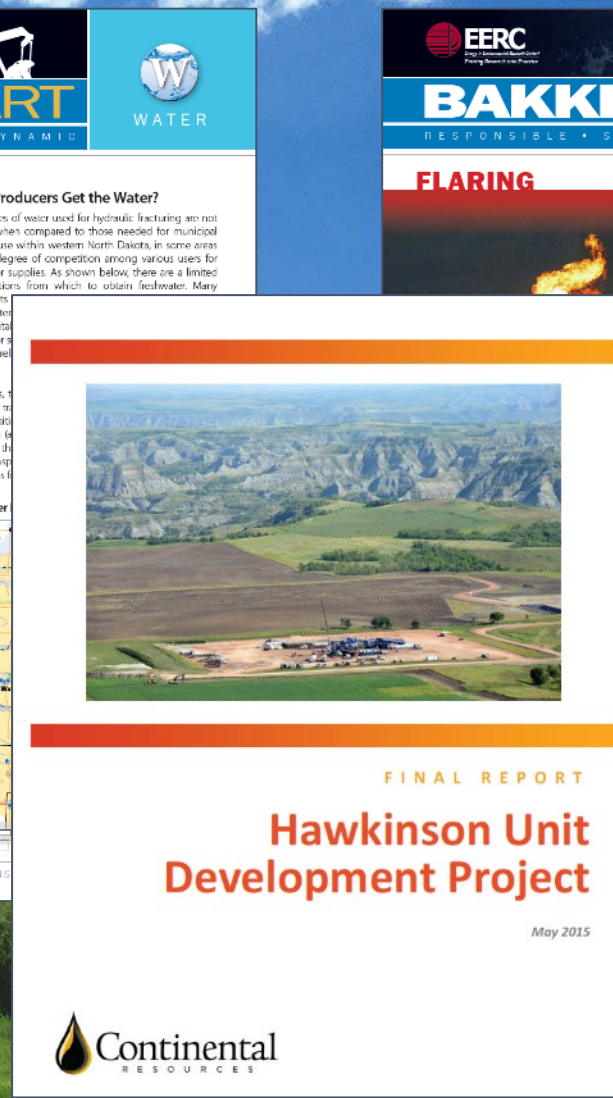
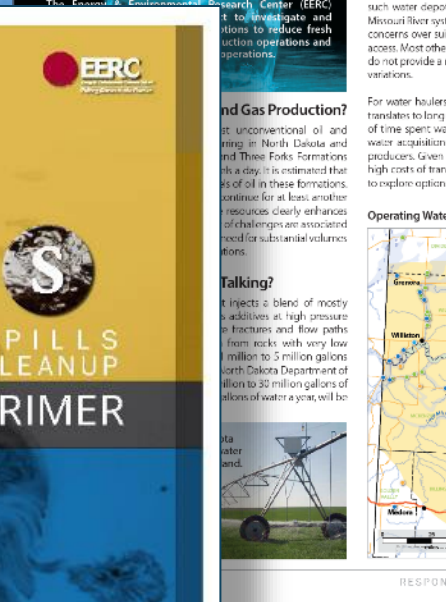
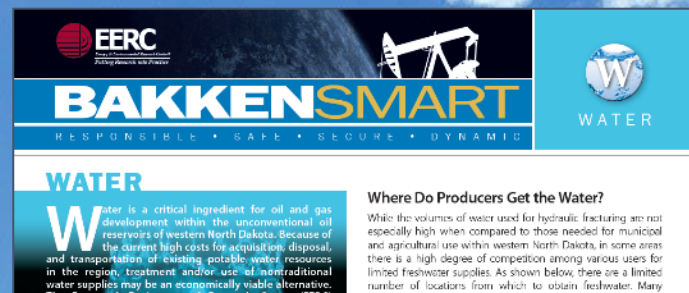
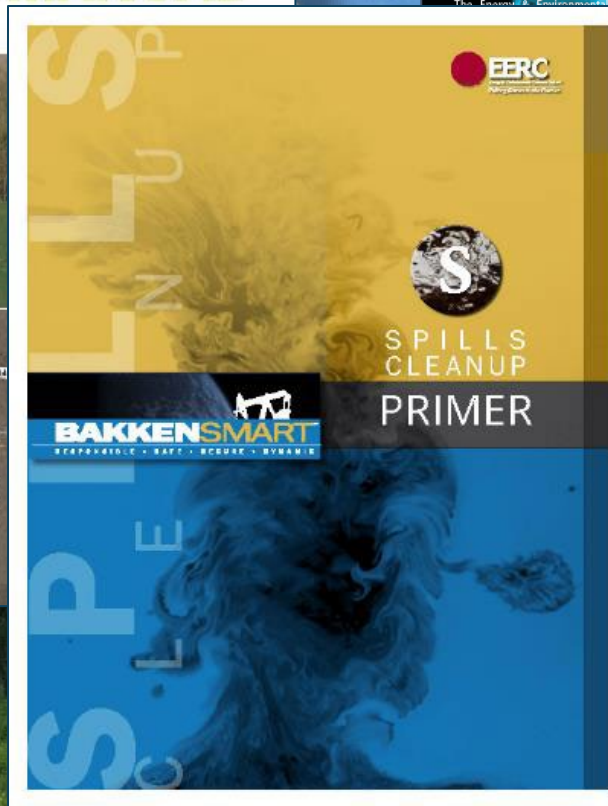
Since 2013, BPOP has been providing technical solutions and tools that optimize oil production.

- Reduce carbon intensity through broad deployment of enhanced oil recovery (EOR), methane emission mitigation, and flare reduction technologies.
- Continue sustainable development of North Dakota's vast Bakken resources.
- Share knowledge through a variety of tech transfer activities and tools.





Products Focused on Optimizing Development Approaches and Reducing Environmental Footprint



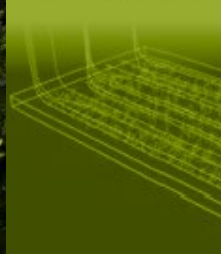
Drilled 11 consecutive wells within a single unit and collected log and core data.



Performed reservoir engineering analyses. Analyzed the data from Phases I and II. Integrated these data and analysis results into cohesive stimulation modeling and numerical reservoir simulations.



Completed 11 wells and collected microseismic and vertical seismic profile data.



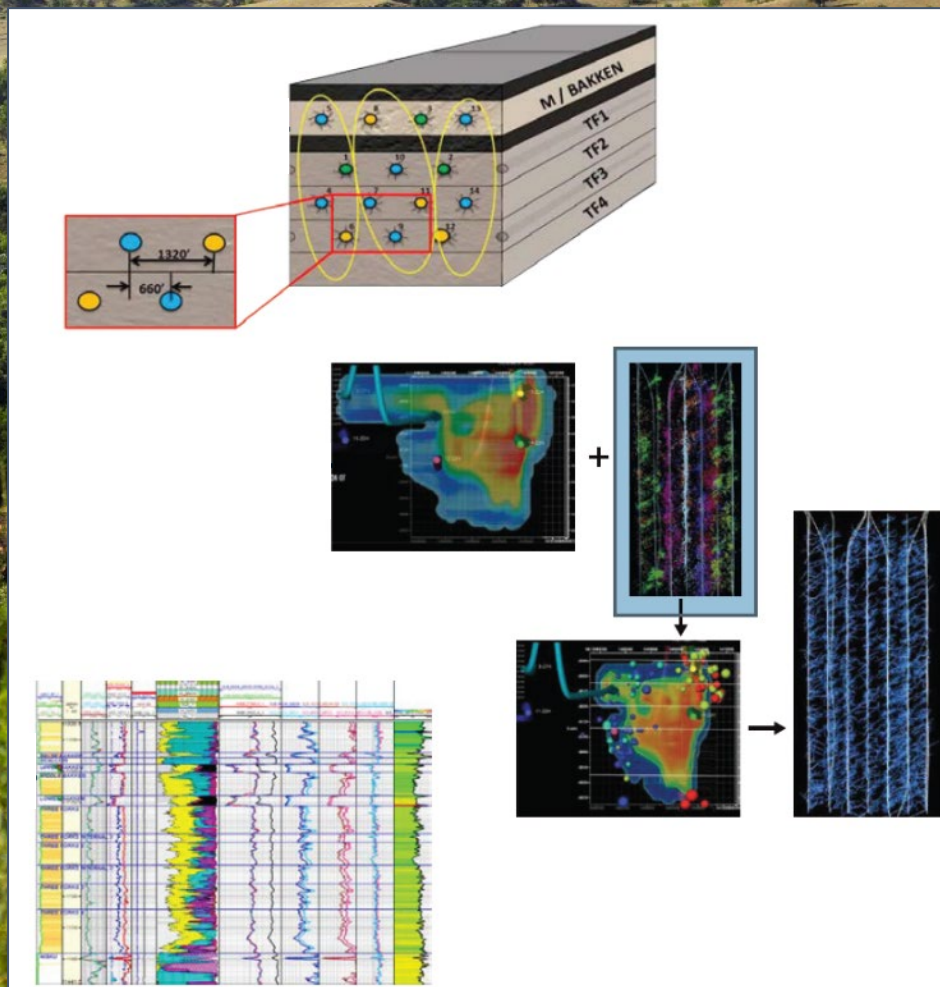
Performed field acquisition, processing, and analysis of 3-D seismic survey.



Hawkinson Unit Development Project

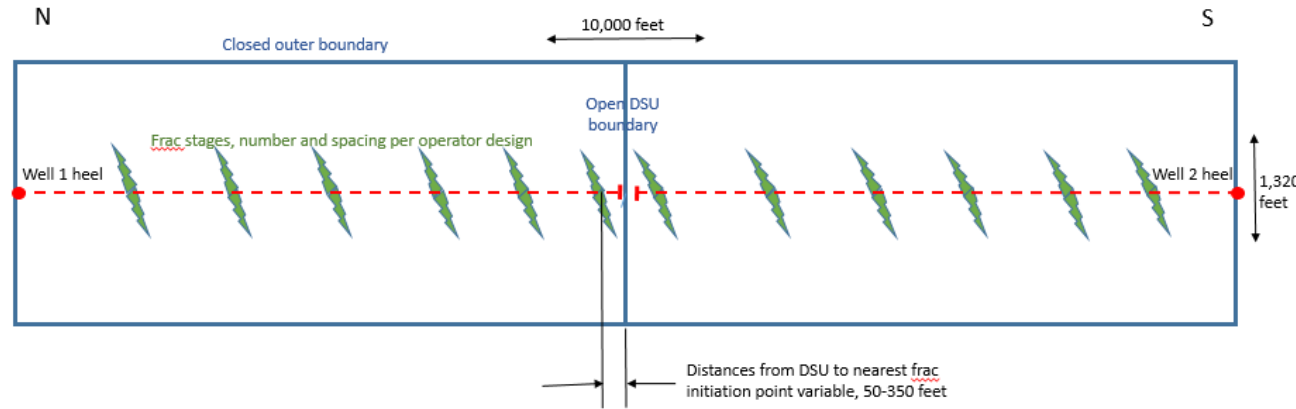


Continental
RESOURCES



2016 BPOP Bakken Setback Study

Bakken-Three Forks DSU Offset Simulation Problem (Schematic Plan View- Not to Scale)



BEFORE THE INDUSTRIAL COMMISSION
OF THE STATE OF NORTH DAKOTA

CASE NO. 25412
(CONTINUED)
ORDER NO. 27926

IN THE MATTER OF A HEARING CALLED ON
A MOTION OF THE COMMISSION TO
CONSIDER AMENDING THE CURRENT
BAKKEN, BAKKEN/THREE FORKS, SANISH,
AND/OR THREE FORKS POOL FIELD RULES
TO ELIMINATE OR REDUCE THE SETBACKS
CURRENTLY ESTABLISHED FOR THE HEEL
AND TOE OF HORIZONTAL WELLS IN ND,
AND SUCH OTHER RELIEF AS IS
APPROPRIATE.

ORDER OF THE COMMISSION

THE COMMISSION FINDS:

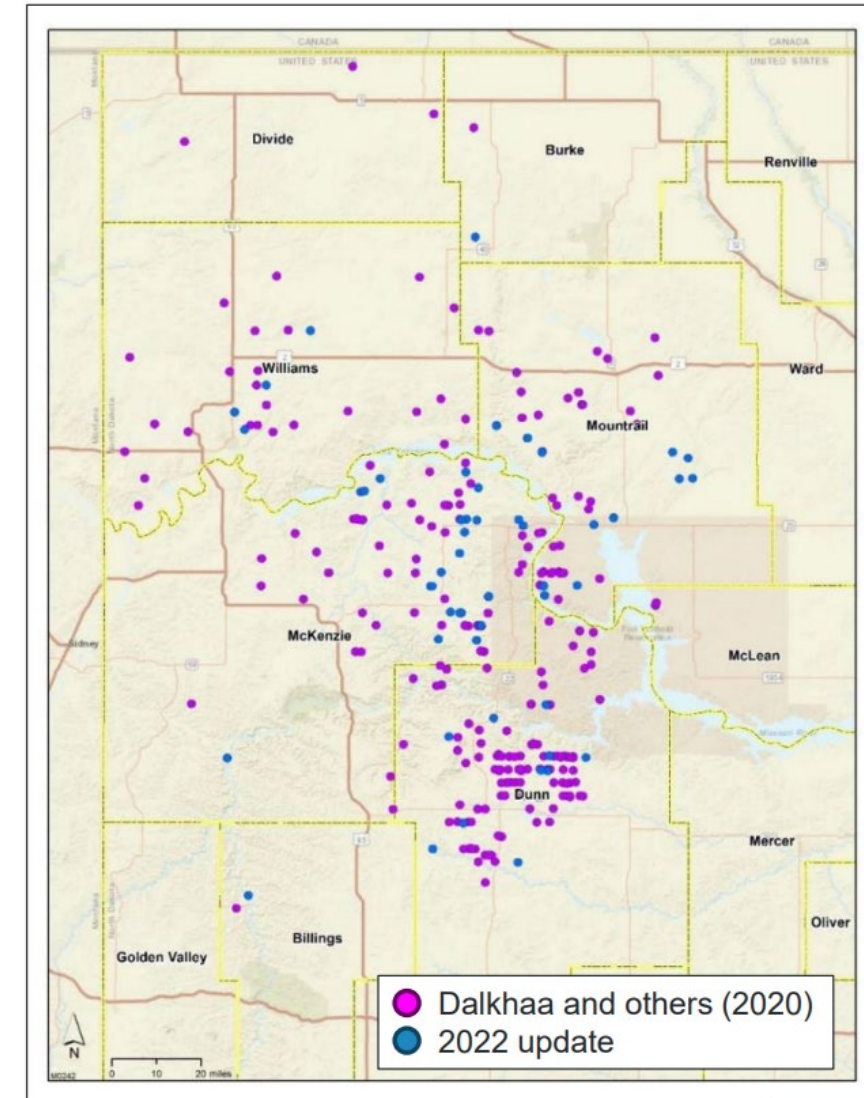
(23) The Commission believes reducing setbacks currently established for the heel and toe of horizontal wells in Bakken, Bakken/Three Forks, Sanish, and/or Three Forks Pool field rules will result in greater ultimate recovery, prevent waste, and prevent the drilling of unnecessary wells, all in a manner which will not have a detrimental effect on correlative rights.

“An estimated return on investment of NDIC funds via the Oil & Gas Research Program was calculated... This anticipated increase in tax revenue is estimated to be approximately \$1.27 billion.”

- Bakken Production Optimization Program Final Report, Years 1-3 (2013-2016), pg. 7.

Refrac Performance Evaluations

- **Evaluation of 341 refracs (as of 2022)**
- **Refrac production performance**
 - Average uplift in daily oil production of 350 bbl/day during initial 30 days following refrac.
 - Incremental estimated ultimate recovery (EUR) ranging from 148 Mbbl to 499 Mbbl, based on decline curve analyses.
 - Avg gas-to-oil ratio (GOR) decrease of 20% during first 30 days after refrac.
- **Frac hits in offsets from refracs**
 - Increase in 90-day average oil production identified in 34 offset wells ranged from 10 to 150 bbl/d.

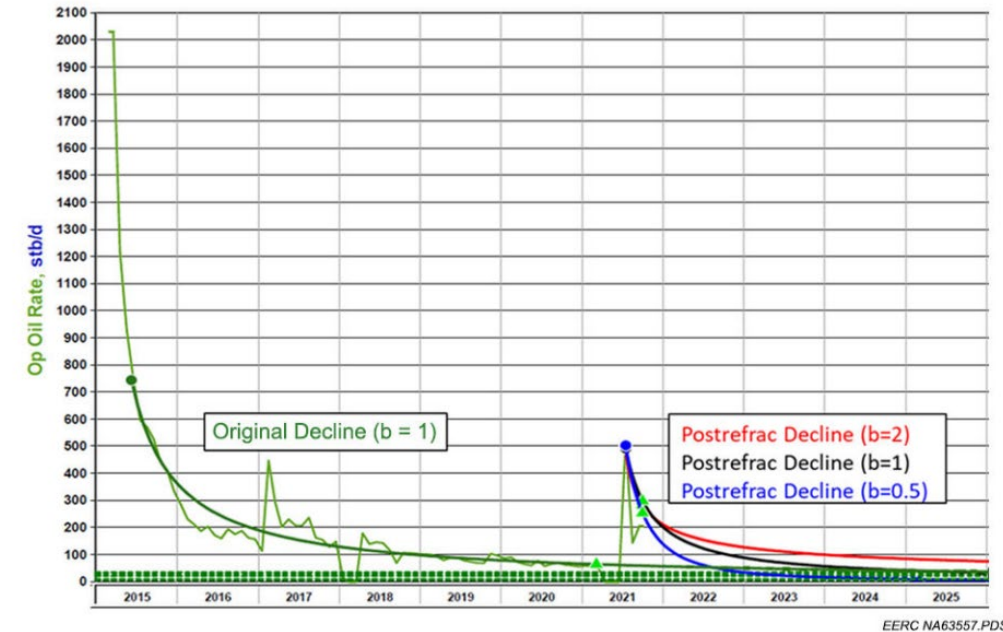


Surface location of refrac wells.

Critical Challenges. Practical Solutions.

Refracs Sustain Production – Stave Off Stripper Status

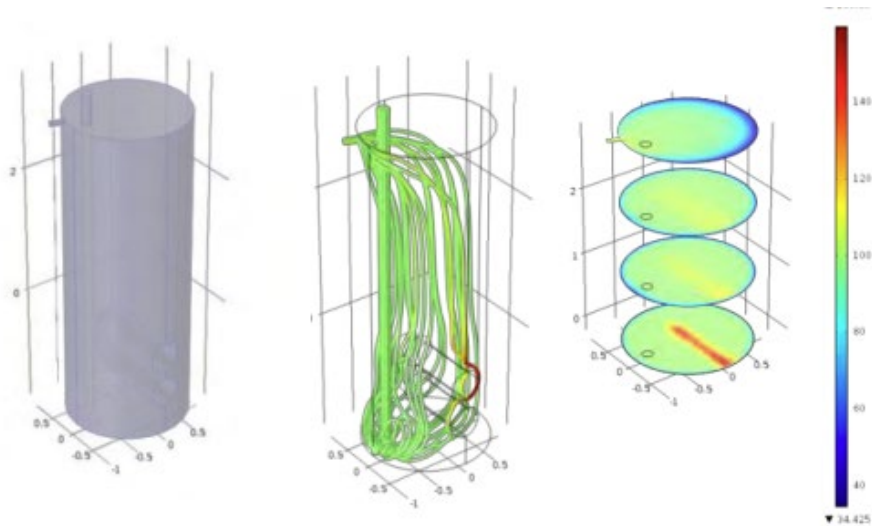
- BPOP efforts have included the development & assessment of re-stimulation technologies (refrac) for Bakken wells that are approaching stripper status
- Refrac production performance
 - Incremental estimated ultimate recovery (EUR) ranging from 150,000 bbl to 500,000 bbl, based on decline curve analyses.
 - At WTI price of \$69/bbl, the value of the incremental EUR per refrac well ranges from \$10.4 million to \$34.5 million.
 - **If all 341 evaluated refrac wells only realized the low range incremental EUR, the total value of the incremental oil produced would be >\$3.5 billion.**
- These results have incentivized Bakken producers to continue their refrac efforts.



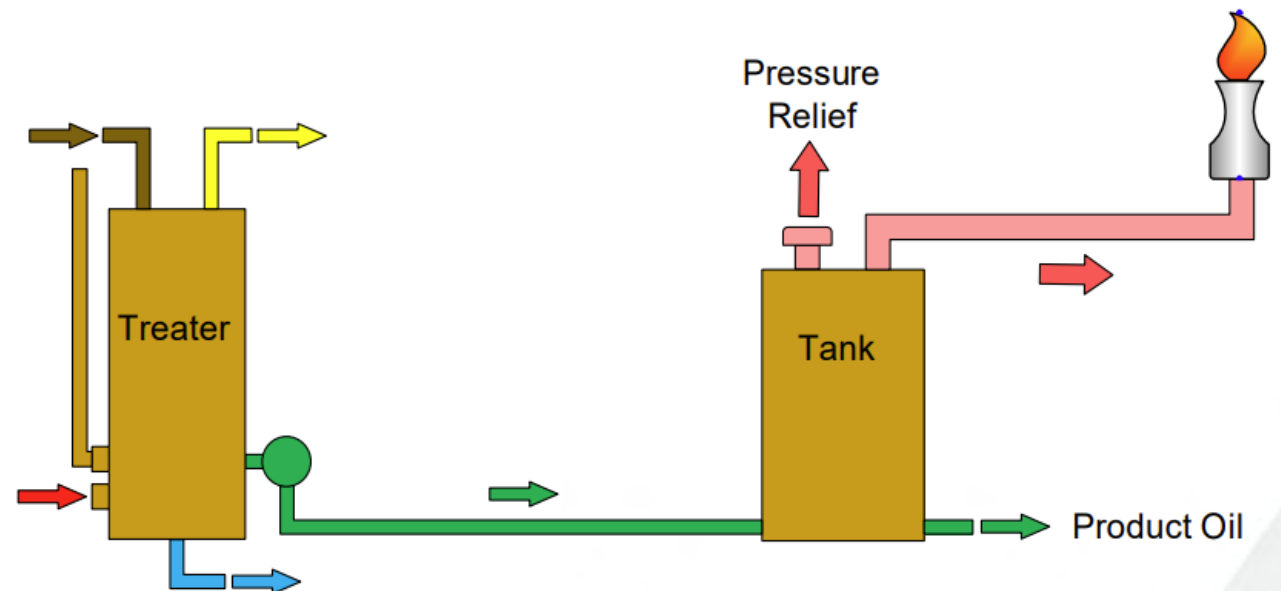
An example of forecasting the incremental EURs using three different b values for the postrefrac decline-curve analysis: $b = 0.5$, $b = \text{prerefrac } b$ (1 in this example), and $b = 2.0$.

Crude Oil Vapor Pressure Management

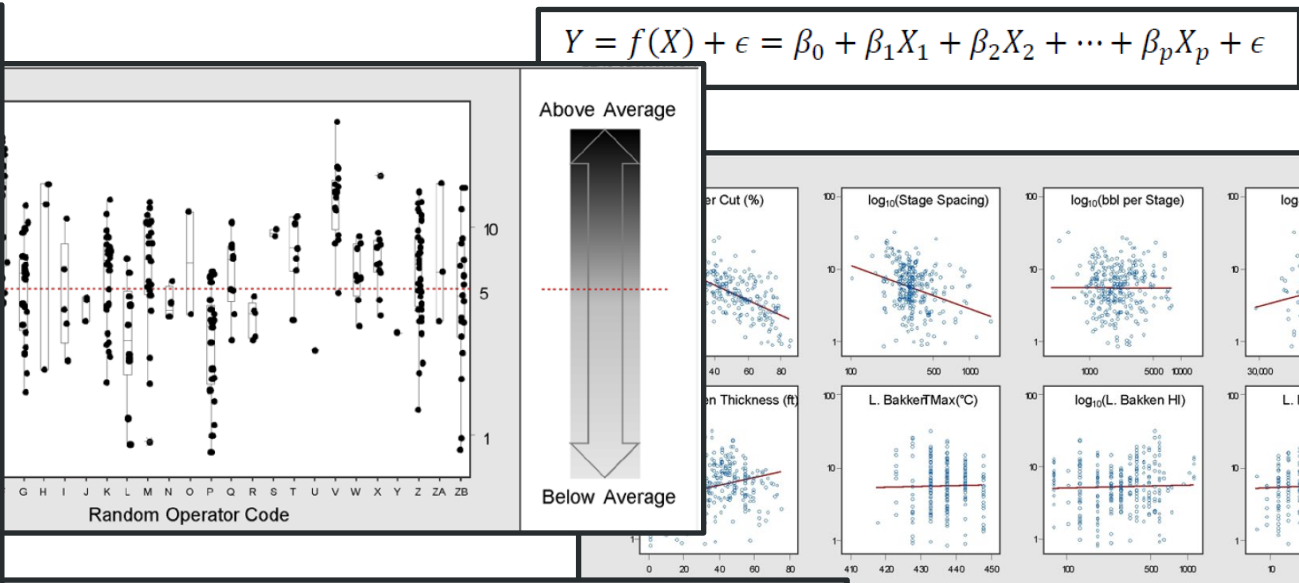
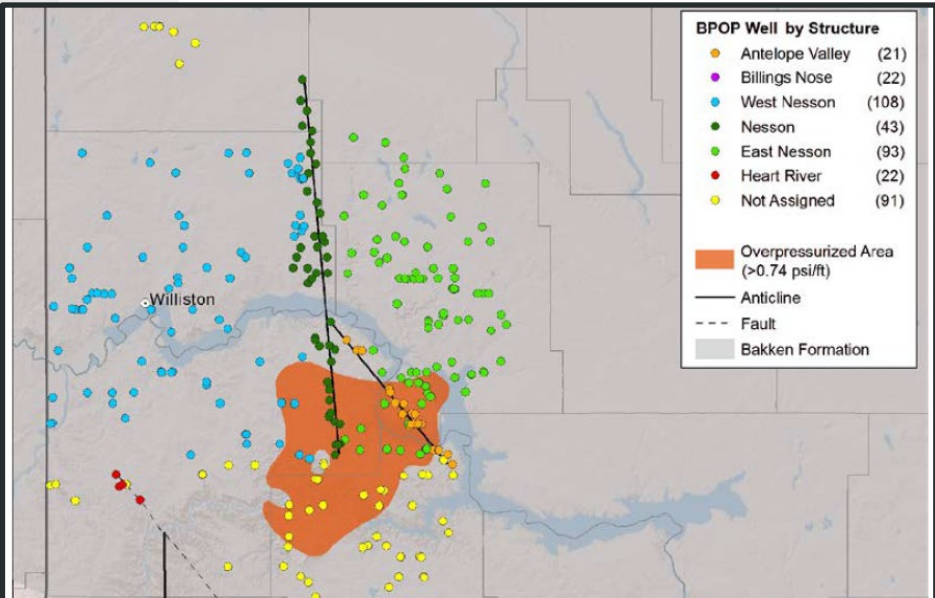
- **Activities:** Worked with BPOP partners to gather data, develop computer models, and validate them with field data.
- **Impact:** Determined optimal conditions for efficient operation:
 - Support compliance with the state and midstream operators in cold weather.
 - Minimize hydrocarbon losses to gas stream in hot weather.



Detailed multiphysics modeling of a treater vessel for performance estimation.



Bakken Data Analytics



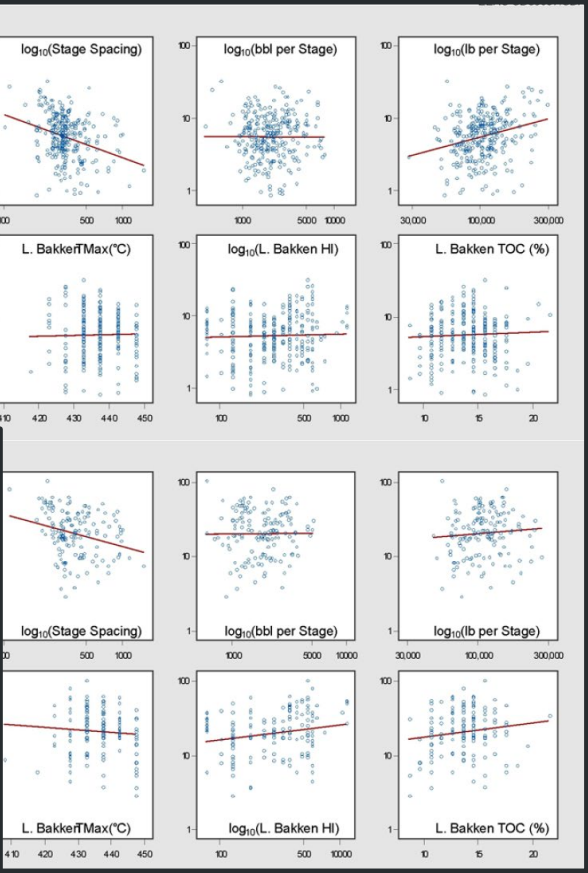
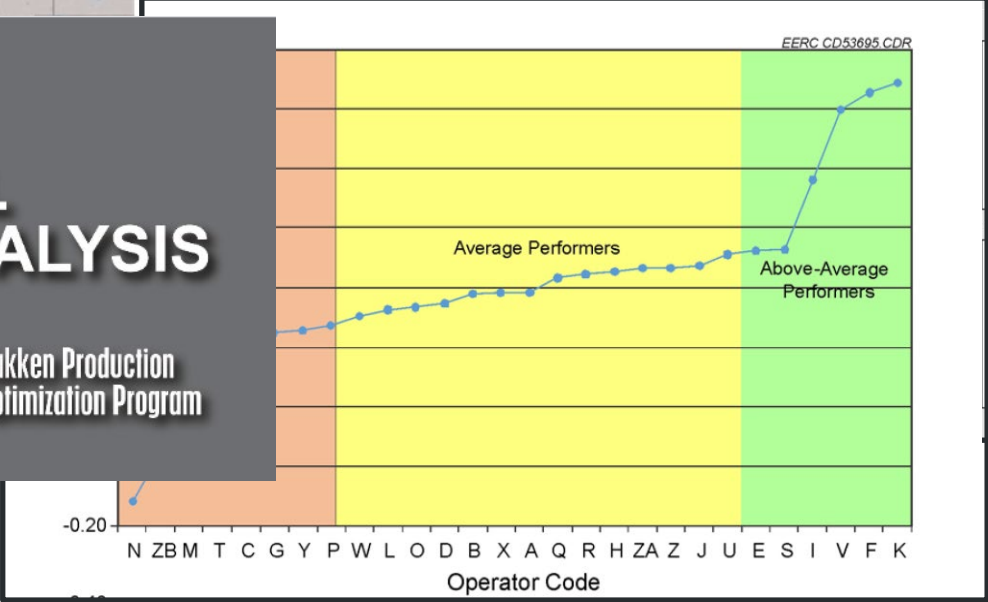
8.5°N

8.0°N

7.5°N

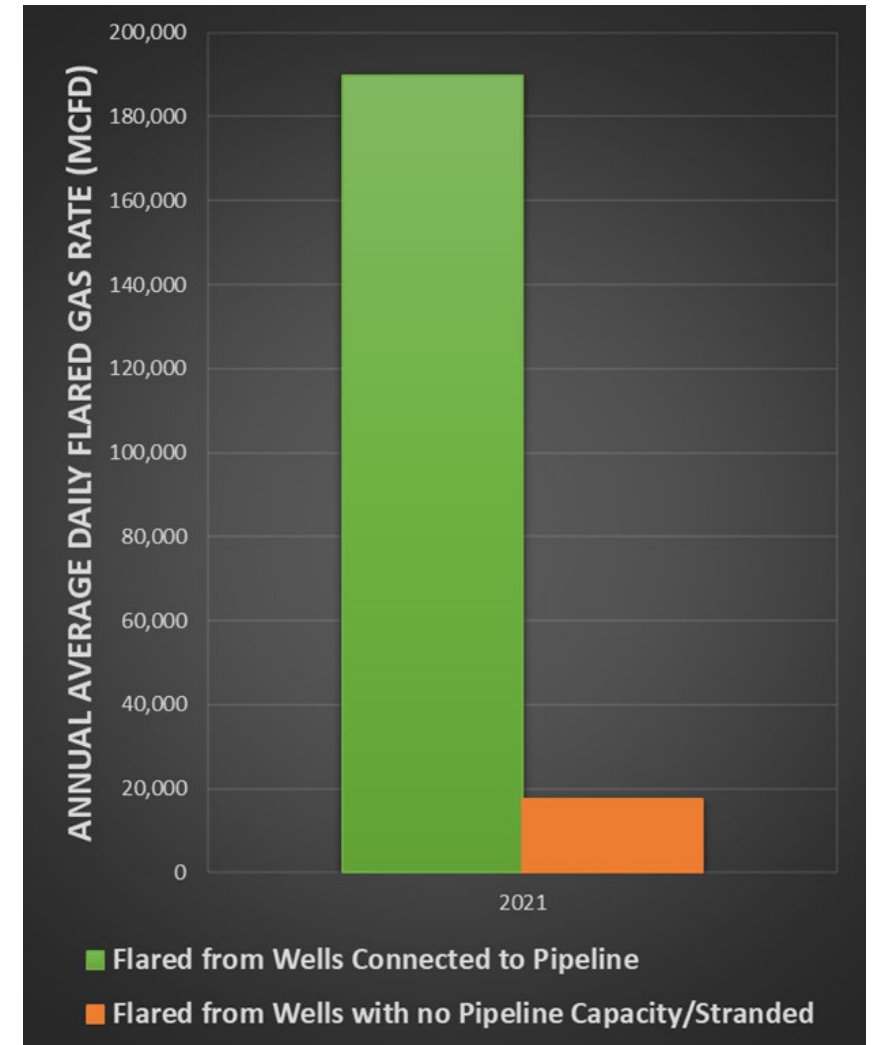
BAKKEN GEOLOGICAL CLUSTER ANALYSIS TOOL

Bakken Production Optimization Program



Flaring and Fugitive Emission Mitigation

- Early BPOP efforts (2013–2014) focused on participation in the North Dakota Petroleum Council's Flaring Task Force to formulate a multistage plan to decrease flaring rates:
 - BPOP provided flaring statistic analysis that served as the foundation for these plans. The BPOP team presented the resulting plan to the governor in January 2014, which is now integral to regulations enforced by ND DMR.
- More recent efforts have focused on development and implementation of a technology (Polar BearSM) that will economically eliminate flaring from wellsites where existing technologies for gas capture are uneconomical.



Methane Emission Mitigation and Flare Reduction Polar Bear™ Technology Development

1

Develop and validate Polar BearSM technology to capture vapors from storage tanks to achieve zero or near-zero methane emissions.

2

Complete engineering-scale testing of a prototype design and validate process controls, design parameters, and safety.

3

Advance Polar BearSM technology for field implementation.



Critical Challenges. Practical Solutions.

Innovation for small-scale industrial compression is needed to eliminate flaring.



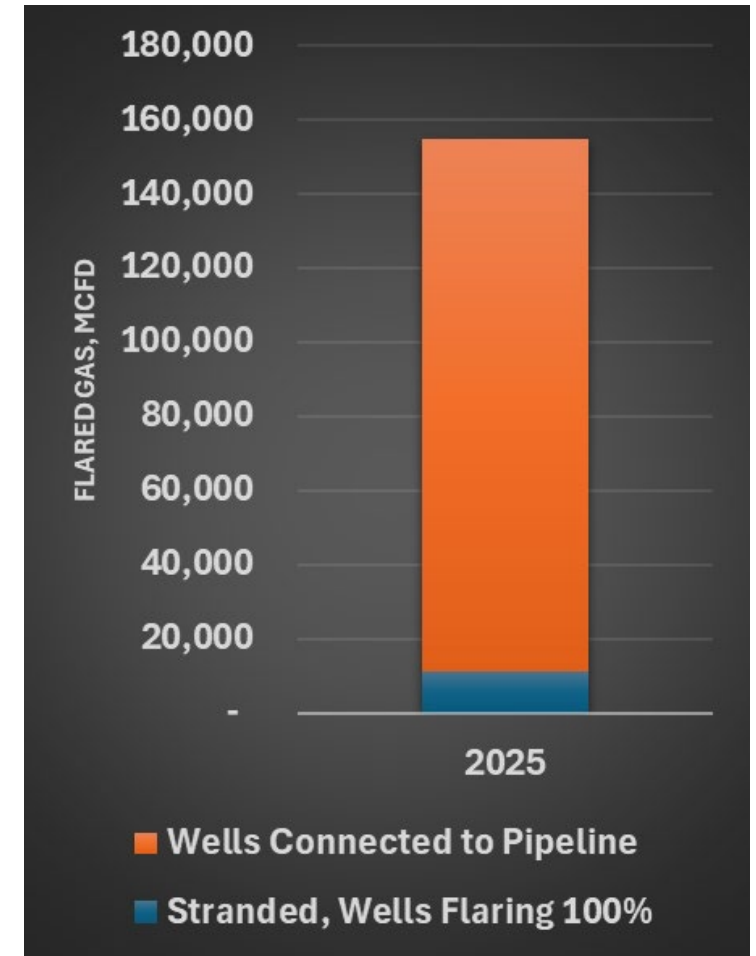
Flaring is geographically distributed.



Many locations flare small volumes that in aggregate, contribute to most of the remaining flared gas.



Solution is needed to capture gas for low flow rates at many locations.



Polar Bear™

Technology Supported by BPOP to Eliminate Flaring.



Polar Bear™ Accomplishments Under BPOP to Reduce Flaring with New Technology

First 5 Units in the Field

Awarded 9 Patents

Manufactured in North Dakota, Steffes

First Oilless Nat. Gas Compressor, Corken

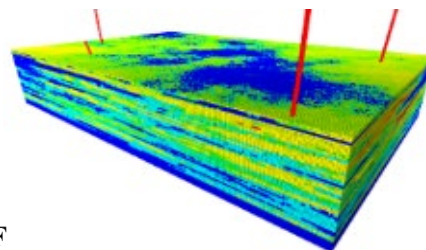
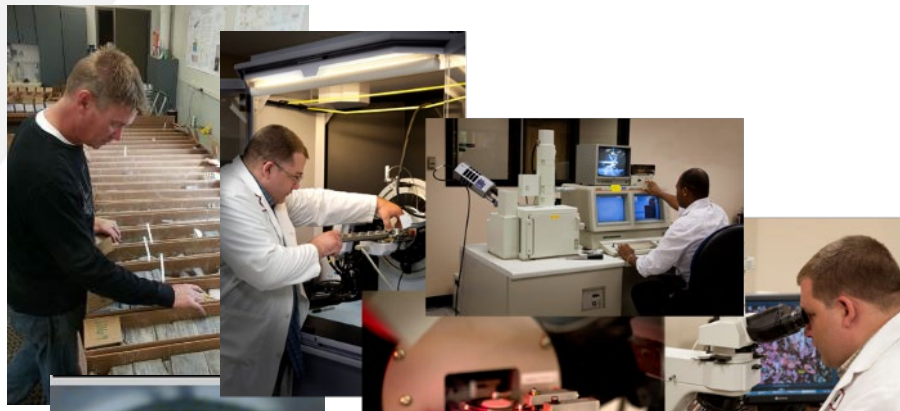
2 Project Awards from DOE

State Grant Awarded to Deploy 30 Units

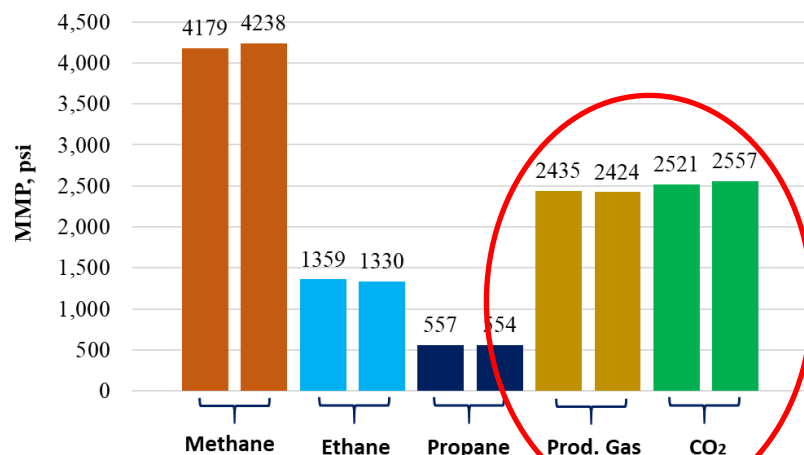


Focus on EOR

EERC laboratory, modeling, and field test activities focused on CO₂ and rich gas for Bakken EOR.



Bakken Crude Oil MMPs, 230 F



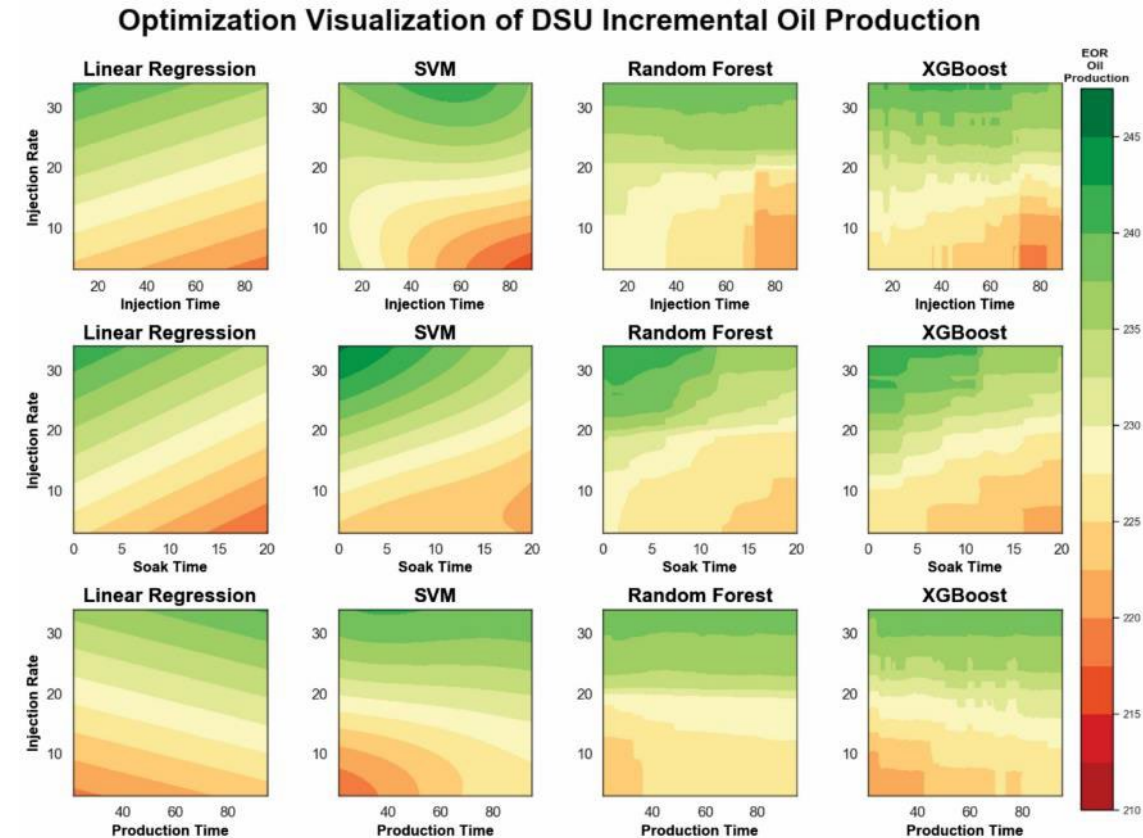
Highlights in the Application of AI and ML for EOR in the Bakken

Artificial Intelligence & Machine Learning for Unconventional EOR Strategies – Created algorithms informing reservoir performance predictions based on injection rate versus soak, production, and injection time.

- Created a tool for real-time visualization and forecasting to support real-time decision-making during production operations.

Modeling Conformance Treatments and EOR Strategies – Explored advanced modeling and simulation techniques to determine mechanisms for improving conformance control in the Bakken, investigate alternative EOR strategies, and improve simulation run times.

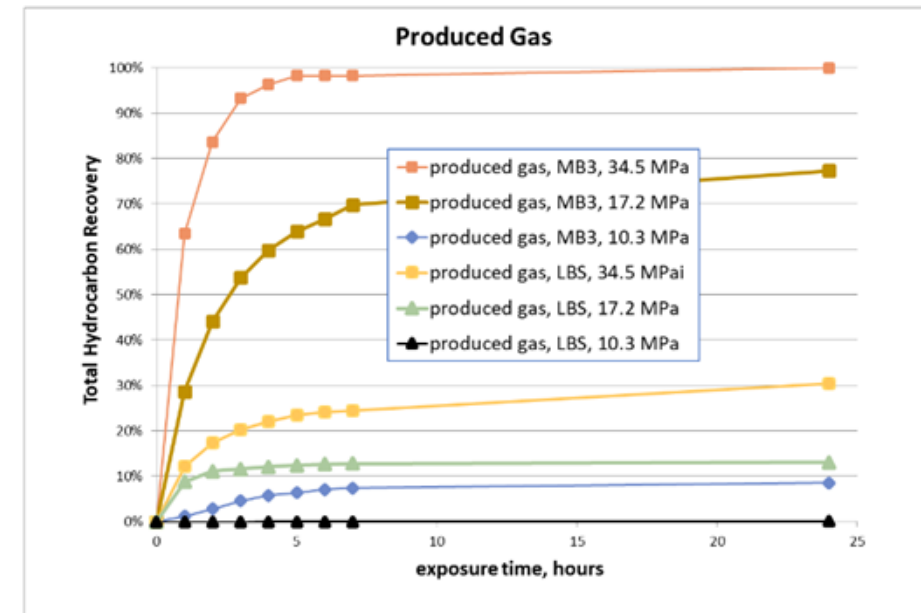
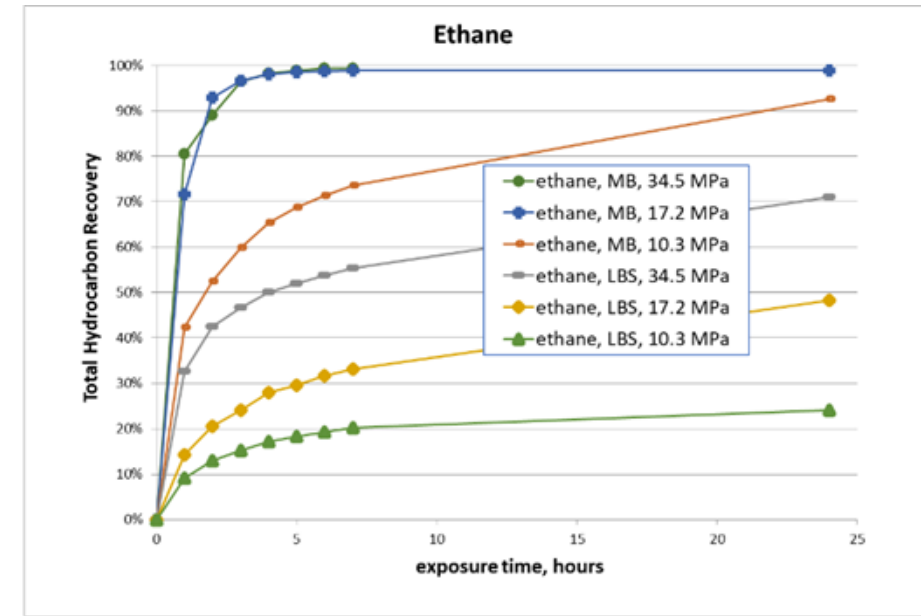
- Embedded Discrete Fracture Modeling (EDFM) was shown to improve simulation run times and demonstrated excellent results matching fluid injection and production data.
- Modeling and simulation studies showed conformance could be gained through water injection or surfactant injection and demonstrated improvements in oil recovery.



EERC SS59475.CDR

EOR Support Activities

- BPOP has supported laboratory-based testing of Bakken crude oil and rock samples to better understand the potential for CO₂ and rich gas EOR in the Bakken petroleum system (BPS). BPOP activities in this space have included the following:
 - Minimum miscibility pressure (MMP) requirements of CO₂, methane, ethane, propane, and blends of gas to solubilize Bakken crude and maximize oil recovery.
 - Evaluation of the ability of various Bakken produced gases and gas blends to permeate various BPS rock types and effectively extract oil.





2017 – Bear Creek

Operator = XTO

Location = Dunn County

Small-scale CO₂ injection test demonstrated **ability of CO₂ to mobilize stranded oil in the Bakken.**



2018–2019 – Stomping Horse

Operator = Liberty Resources

Location = Williams County

Multi-well rich gas EOR pilot demonstrated ability to **build reservoir pressure and keep the injected gas in the drill spacing unit.**



2021–2024 – East Nesson (2 pilots)

Operator = Liberty Resources

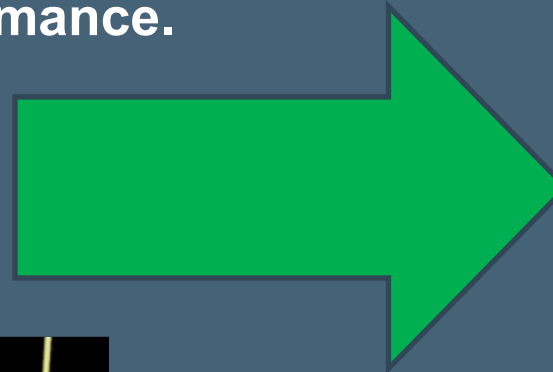
Location = Mountrail County

2 EOR pilots. First used injection of rich gas rapidly pulsed with freshwater and surfactant. Second used more traditional WAG approach with rich gas and produced water. Both **demonstrated clear evidence of several thousands of barrels of incremental oil over pilot period of performance.**

Bakken CO₂ EOR and Storage Field Lab

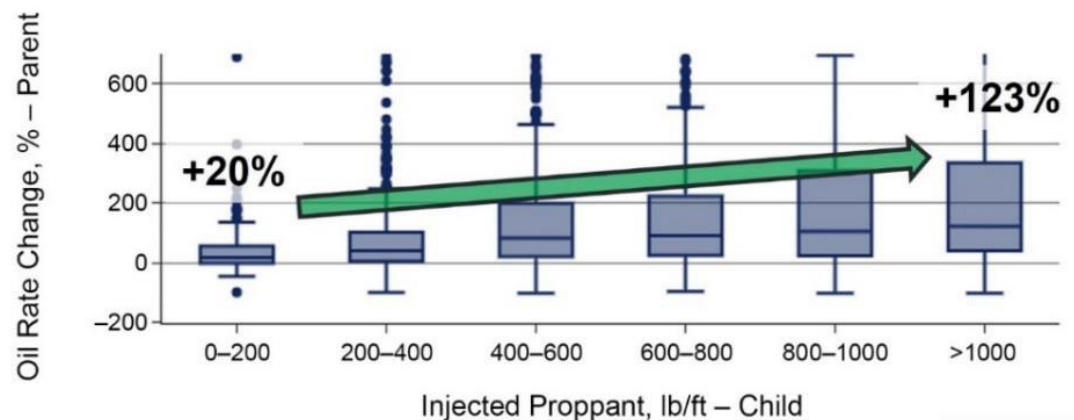
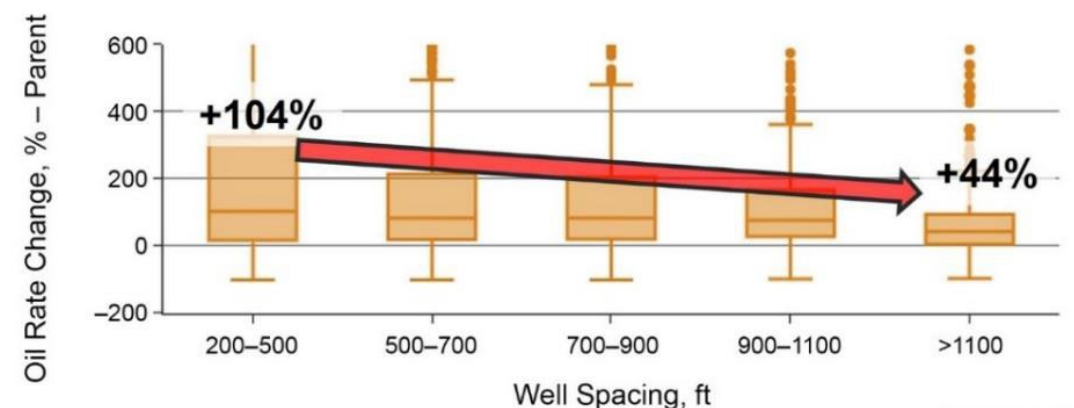


\$11.6 MM of funding from USDOE with significant commitment from Chord Energy for lab work, modeling, design, and operation of 18-month EOR pilot. Project initiated in September 2024 with a 4-year period of performance.

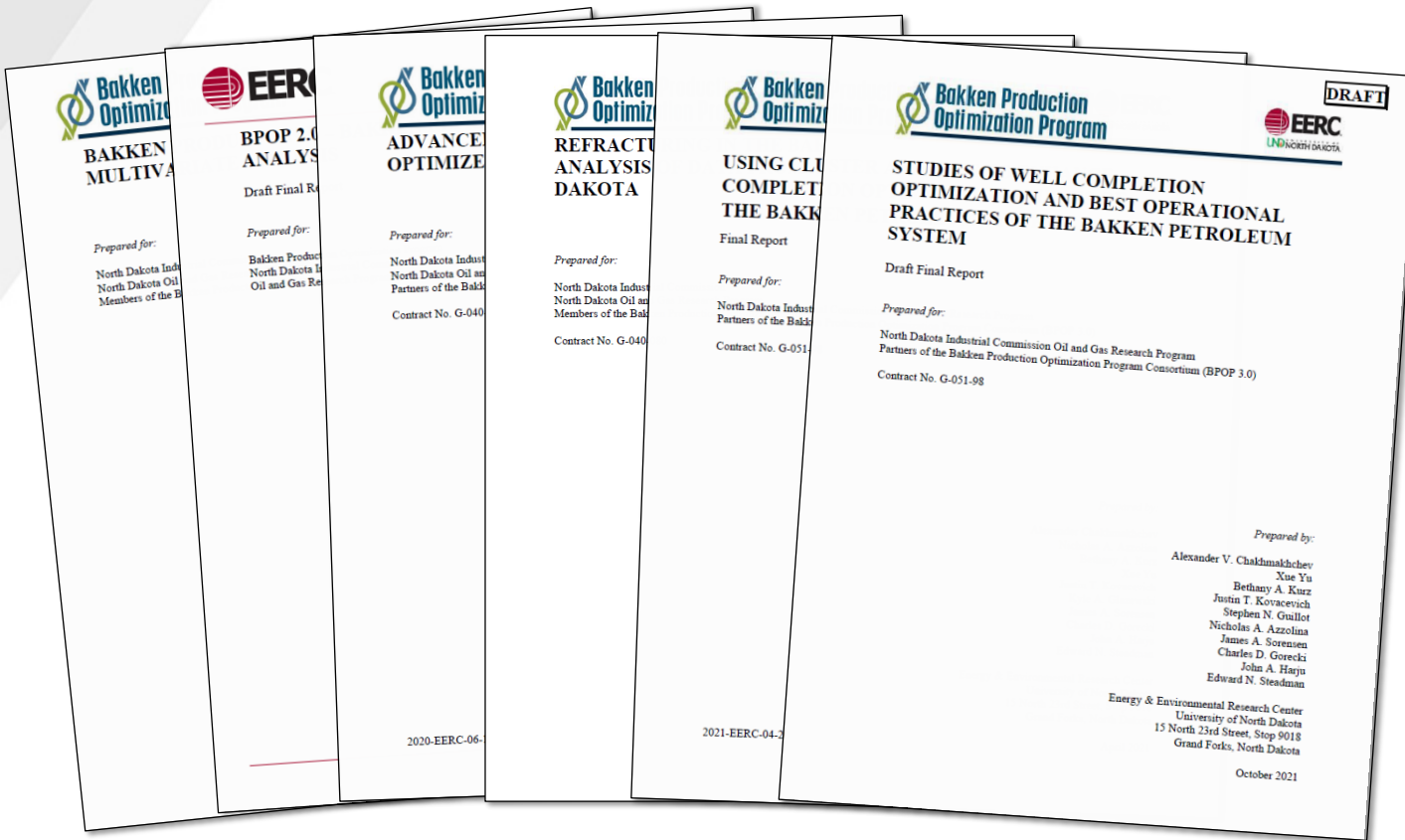


Completion and Production Data Analytics

- The BPOP team applies state-of-the-art statistics and ML tools to identify key factors affecting oil, gas, and water production. Key topics include:
 - Quantify relationships between completion type/size and well production.
 - Evaluate completion optimization.
 - Assess parent–child well interactions and optimal DSU development.
 - Estimate core area expansion and future Bakken development potential.

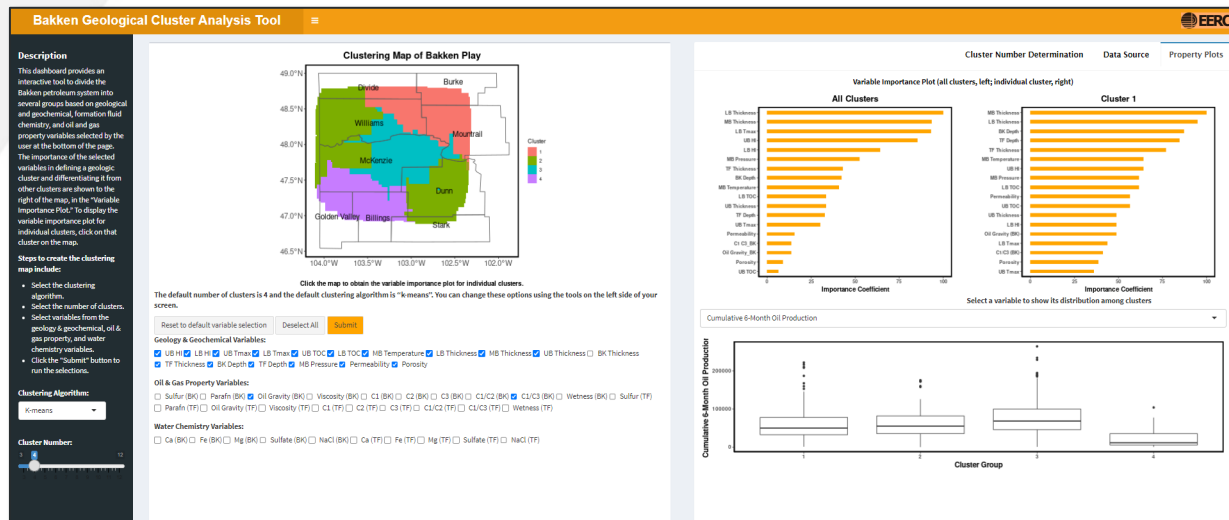


Examples of Data Analytics Work Products



- Well completion and production studies
- Refractured wells studies
- H₂S in Bakken production studies
- Online tools developed
- We apply state-of-the-art statistics, AI and ML tools to broad data sets of geological parameters, well completion and production to draw inferences about Bakken production and optimization.

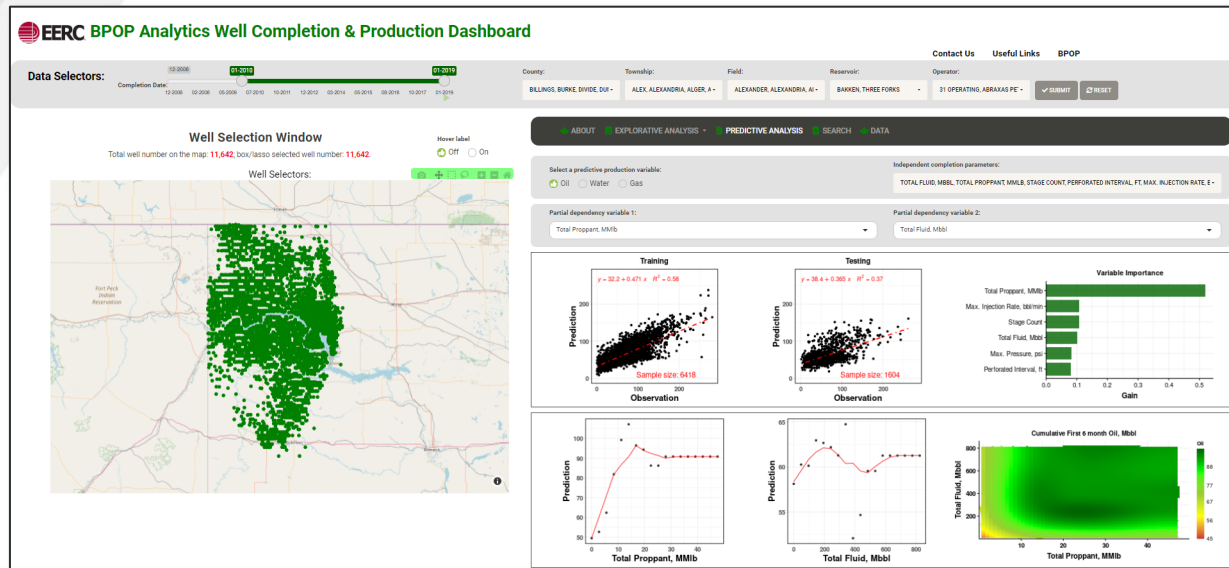
Geological Cluster Analysis Tool



- An interactive tool that subsets BPS into groups based on geological and geochemical, formation fluid chemistry, and oil and gas property variables selected by the user at the bottom of the page.
- The importance of the selected variables in defining and differentiating a geologic cluster from other clusters is shown to the right of the map in the "Variable Importance Plot." The user can click on that cluster on the map to display the variable importance plot for individual clusters.
- The tool provides value to our BPOP partners by providing an interactive resource for exploring the Bakken, investigating the relative importance of different features within specific geographic areas, and rapidly screening large amounts of information before moving forward with more detailed, site-specific analyses.

The Bakken Geological Cluster Analysis Tool can be found on the Partners-Only Website!

Well Completion and Production Dashboard



- An interactive tool that allows the user to select a set of wells from BPS; explore relationships between oil, gas, and water production and several well completion parameters; and fit ML models.
- The predictive modeling uses Extreme Gradient Boosting (XGBoost) as the algorithm to construct predictive models for selected wells to predict well oil, gas, or water production (the response or target variable) from a set of user-defined completion parameters (the independent variables of features).
- The tool provides value to our BPOP partners by providing an interactive resource for exploring the Bakken and investigating which completion parameters drive oil, gas, and water production within subsets of the Bakken and rapidly screening large amounts of information before moving forward with more detailed, site-specific analyses.

The Analytics Well Completion & Production Dashboard can be found on the Partners-Only Website!

Carbon Intensity Tool

Carbon Intensity Tool

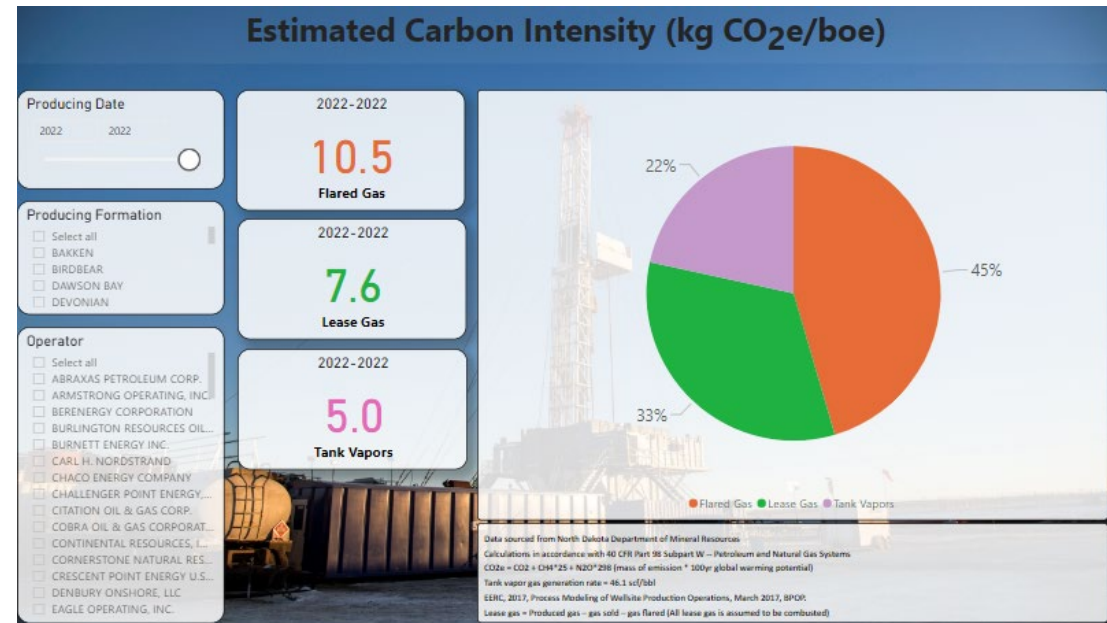
Premium

Date Published: 9/26/2022

'This dashboard provides an interactive tool to assess North Dakota oil & gas production related carbon intensity (kg CO₂e/boe). Produced Gas, Flared Gas, Lease Gas, and estimated Tank Vapors data is presented over time, shown geographically, and grouped by Central Tank Battery (CTB) f...'

Provides BPOP partners a means to examine temporal data pertaining to carbon intensity:

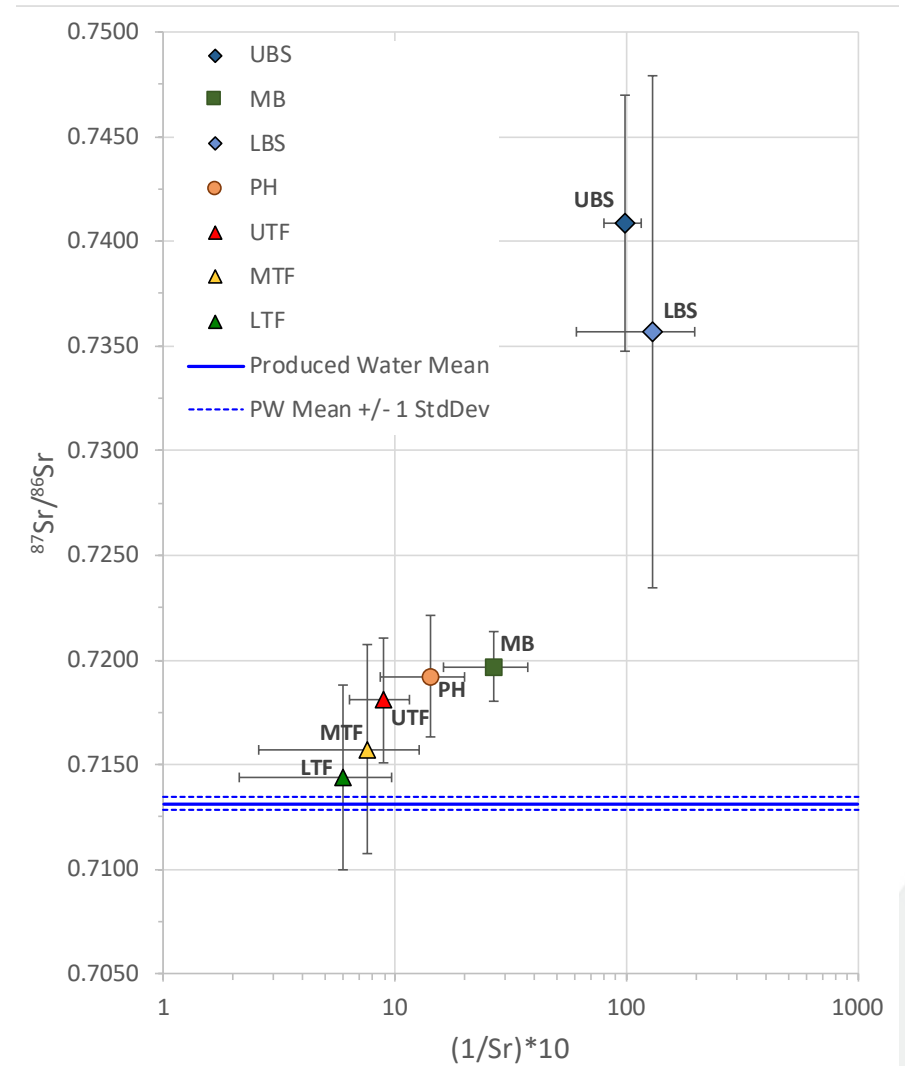
- Flaring
- Tank vapors
- Production plots
- Flaring profiles
- Geospatial tools and mapping



Produced Water and Oil Fingerprinting

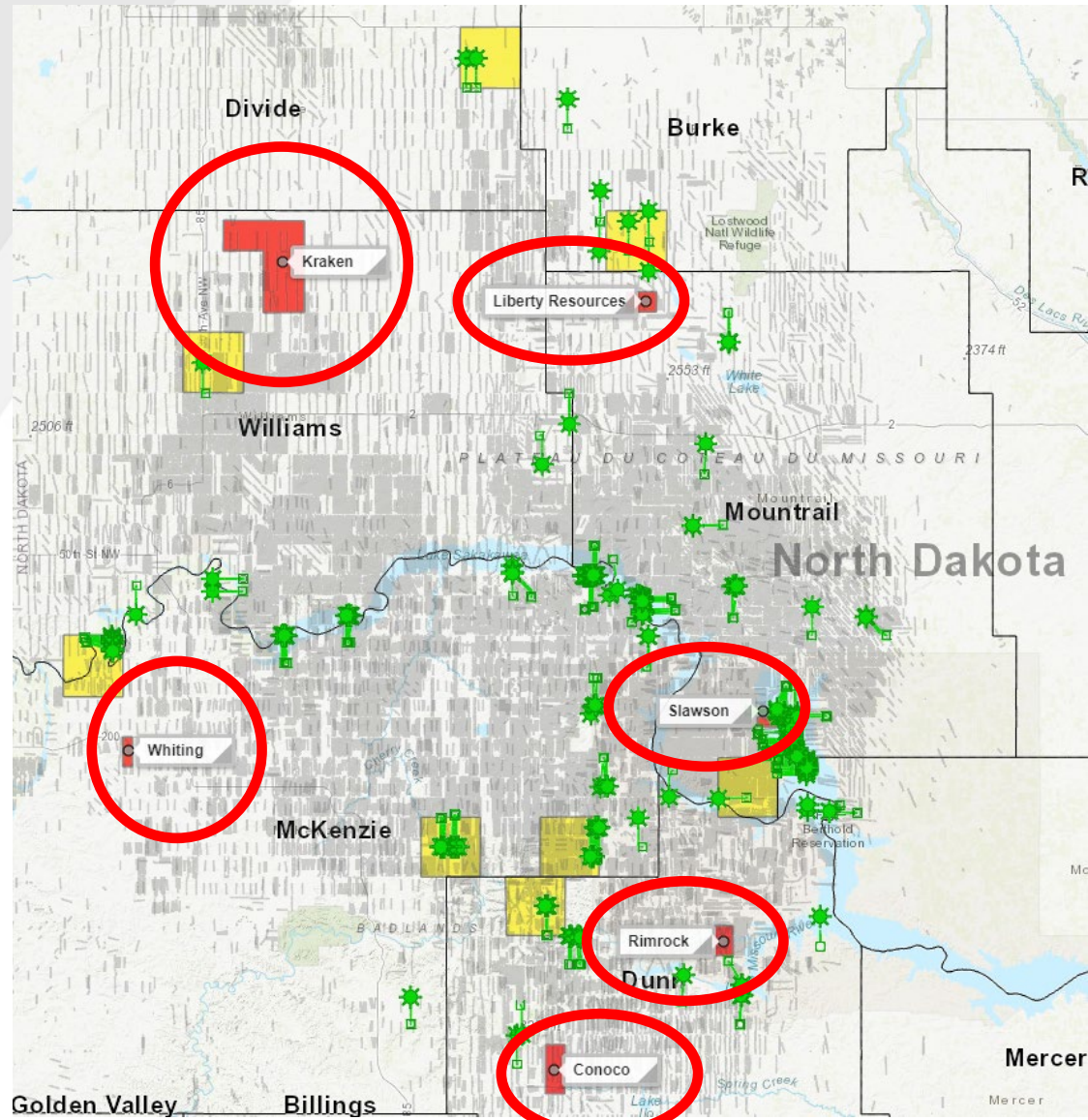
The BPOP team has been developing and testing fingerprinting techniques for produced fluids (water and oil) and rock extracts to:

- Evaluate reservoir continuity.
- Understand reservoir drainage volume.
- Evaluate reservoir communication and mixing.
- Monitor production and compositional changes in produced fluids.
- Understand hydrocarbon charge from source rocks.



Critical Challenges. Practical Solutions.

Evaluation of 3-mile Laterals

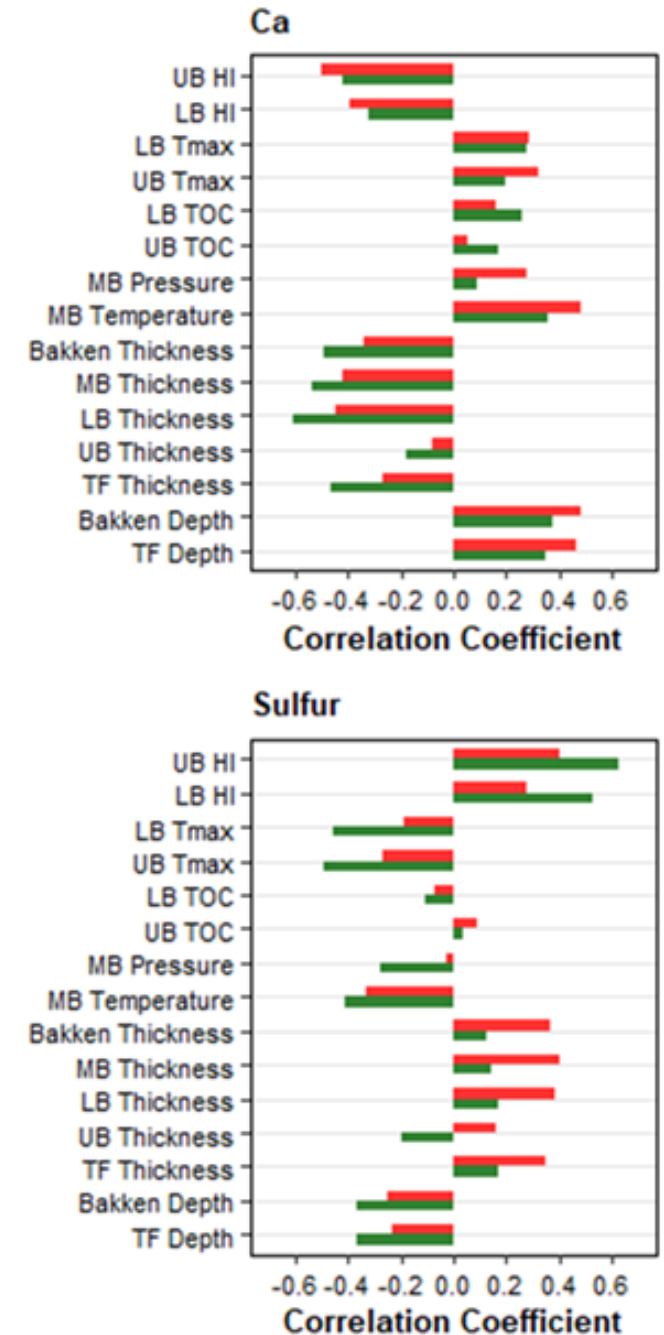


- As operators look for new ways to develop acreage outside of the core, BPOP investigated the history and prospect for 3-mile lateral wells.
- Extensive analysis was completed to compare **similar acreage** between 2- vs. 3-mile horizontal well performance.
- Data set: 235 wells dating back to 2011.
- Results provide insights to anticipated well performance targeting 50% additional EUR per well.
- Operators are pushing forward with 3-mile lateral plans. Development is no longer driven by geography and occurring in core and noncore areas.
- 70% of operators appear to be realizing anticipated additional production.

The red circles indicate new 3-mile horizontal well developments.

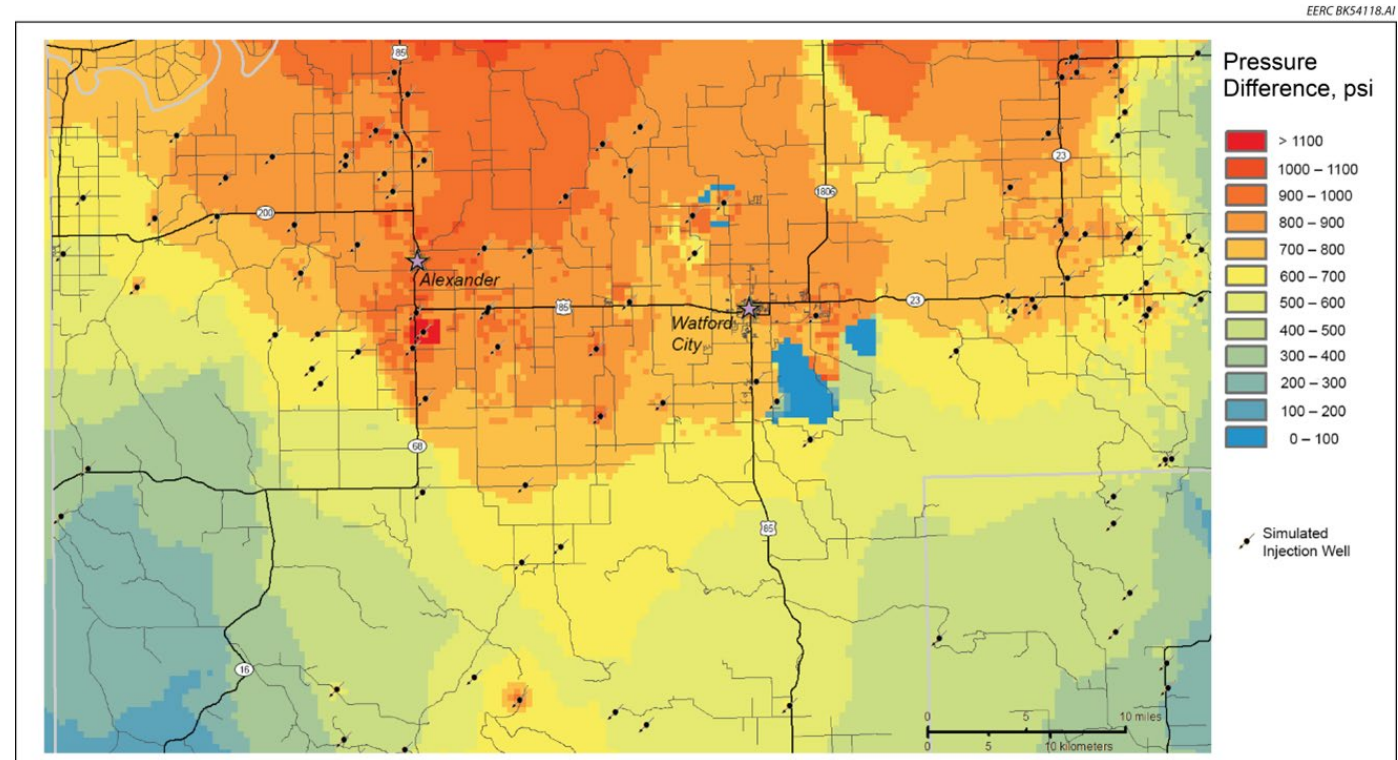
Produced Fluids Characterization

- Through BPOP, the EERC has developed and continues to expand a data set of produced fluids compositions (brine and oil) to monitor changes in chemistry over time and to evaluate chemical differences in the different geologic units of BPS.
- The data collected through BPOP, coupled with the fluids fingerprinting techniques developed by the team, are being used to better understand the contribution of fluids from different zones (within and overlying/ underlying BPS) within produced oil and brine.



Saltwater Disposal Potential of the Inyan Kara

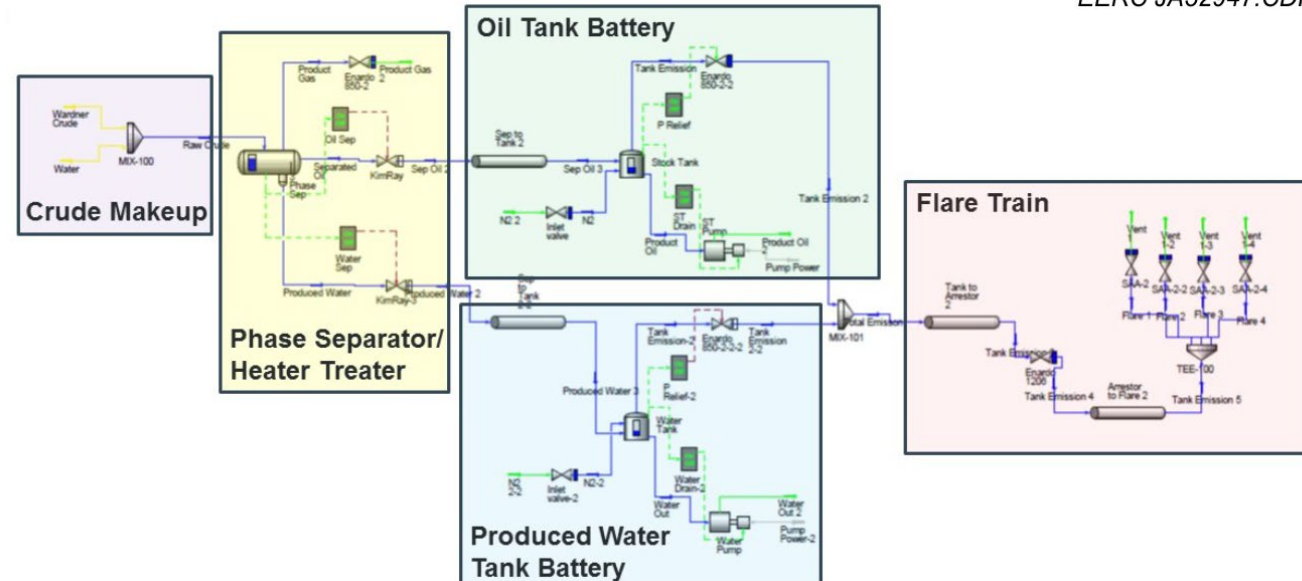
- Because of industry's reliance on the Inyan Kara Formation as a saltwater disposal (SWD) target, the BPOP team performed modeling and simulation to estimate local and regional pressure effects that have occurred as a result of historic SWD.
- Areas that may be suitable or problematic for disposal were evaluated through reservoir simulation of hypothetical future injection scenarios.



Facility Process Optimization

- Surface facilities are a key link in the overall Bakken production chain. Through BPOP, models were created with partner input to examine, in detail, parameters that affect fugitive emissions and crude oil properties.
- The modeling results were used to derive actionable suggestions for partner producers to consider in their facility operations as well as new, novel methods of operation.

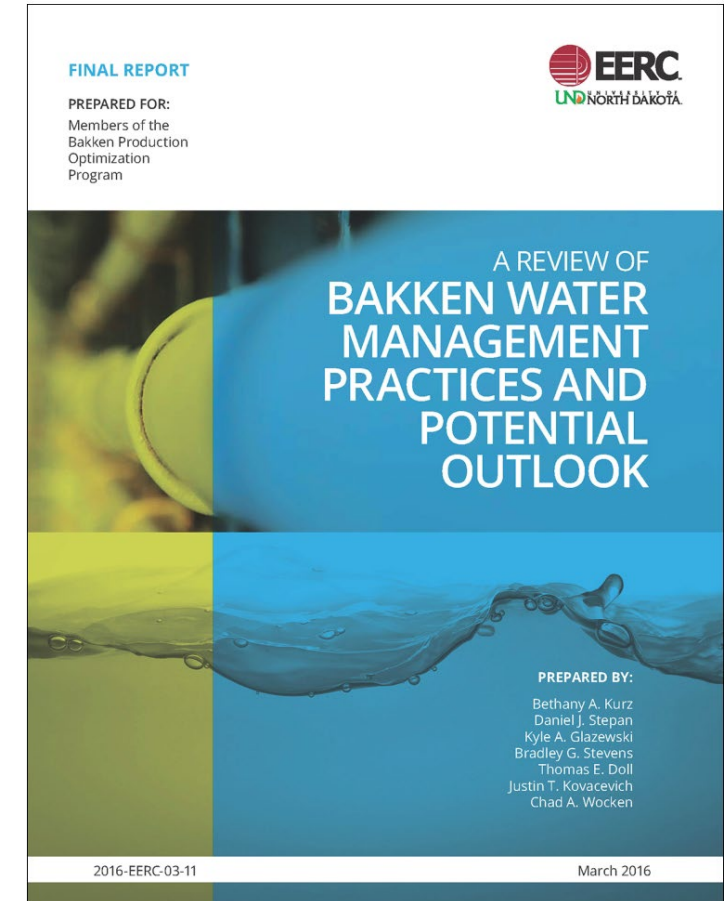
EERC JA52947.CDR



Additional Accomplishments

- **Bakken Water Opportunities Assessment**
 - Performed two evaluations of key water use and handling issues in the Bakken, including estimation of future water supply and brine disposal needs, evaluation of brine treatment technologies and their applicability for Bakken produced water, and considerations for brine recycling and reuse.
- **Technical Forums for Industry**
 - BPOP provided a regular forum for peer-to-peer technical discussions on issues affecting all partners. Partners commented that this function is available nowhere else.

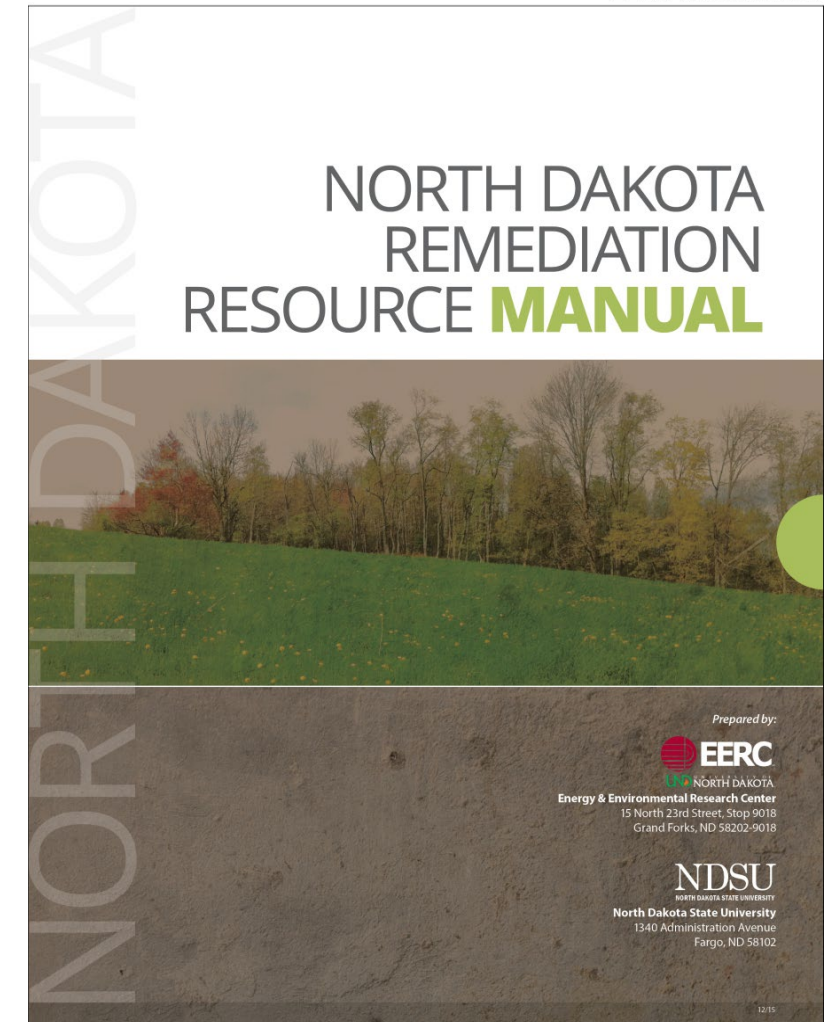
EERC JA52952.CDR



Additional Accomplishments

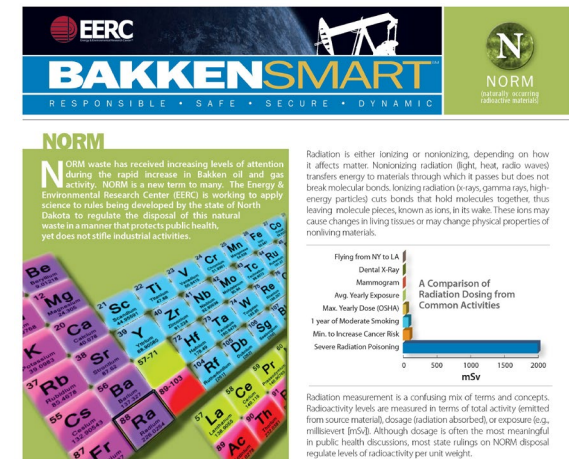
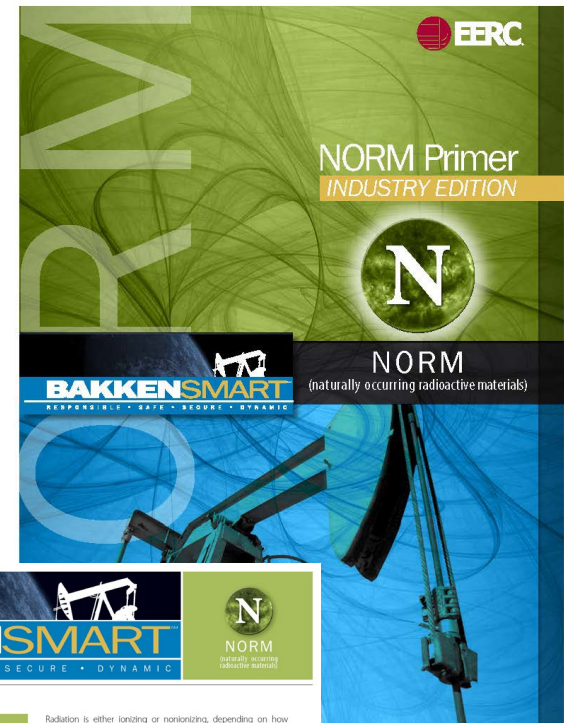
- **Remediation of Brine Spills**
 - BPOP coordinated discussion with state regulators and industry groups on the topic of best practices for remediation of brine spills associated with oil development. Based on the data and feedback received from these discussions, as well as from current research and literature, the EERC completed a best practices remediation manual that was shared with the state and industry.

EERC JA52956.CDR



Norm-Related Support

- BPOP representatives served as subject matter experts and advisors to NDPC's Naturally Occurring Radioactive Materials (NORM) Task Force.
- BPOP produced a series of NORM-related fact sheets and a primer to educate the general public on NORM and how NORM is regulated in North Dakota.
- The EERC coordinated a NORM sampling effort among several oil producers to further evaluate levels of NORM in drill cuttings, produced water, and fracturing fluid flowback. The results were interpreted by the EERC and used to help inform the state and the NORM Task Force.
- This work was performed before the term Technologically Enhanced NORM (or "TENORM") became the preferred term, but the concepts and knowledge are still applicable.



BAKKENSMART

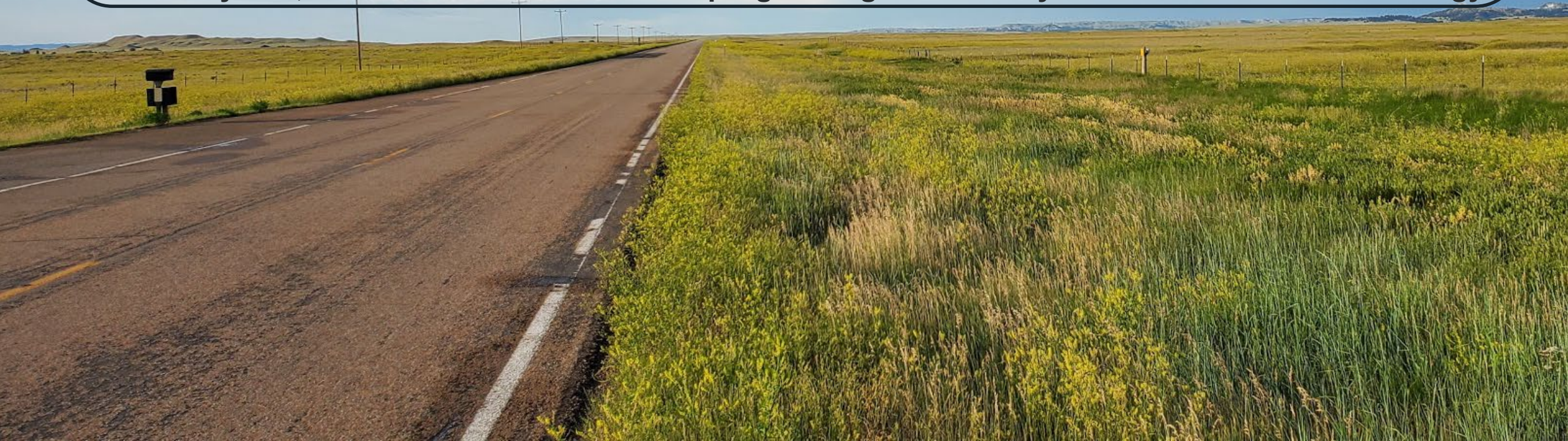
RESPONSIBLE • SAFE • SECURE • DYNAMIC

Critical Challenges. Practical Solutions.

BPOP 4.0 Key Takeaways...

Enhanced Oil Recovery

- How recovery rates from the Bakken can be dramatically increased over primary production is a significant question that remains to be solved. BPOP continues to make progress in the field with pilot projects that provide learnings for the industry and build confidence in the application of enhanced oil recovery (EOR). BPOP has demonstrated that conformance of injected fluids can be maintained within drilling spacing unit (DSU) boundaries and that with sufficient volumes, injection of miscible fluids yields incremental oil. As many gas EOR strategies have stalled in recent years, BPOP has been essential in progressing the industry towards a viable EOR strategy.



BPOP 4.0 Key Takeaways...

Environmental Performance

- North Dakota's industry is exceeding the state's gas capture rules that were implemented in 2014, however the goal to eliminate flaring is yet to be achieved. BPOP research is progressing a new gas capture technology that makes it affordable to capture remaining flared volumes in North Dakota. Research and development supported by BPOP has resulted in the first field pilots of that technology that will operate during the next phase with the support of the DOE. The technology greatly improves the economics of gas capture addressing the affordability of eliminating flaring.



BPOP 4.0 Key Takeaways...

Data Analytics Supports Bakken Advancements

- The industry is quickly changing with more economic completion practices including 3 and 4+ mile laterals and wells that U-bend within drilling spacing units that decrease the expense of additional wellheads, vertical well casing, and facilities. The EERC's data analytics provides valuable insights for the members of BPOP in analyzing production from these new developments that help steer the industry and drive investment especially for underdeveloped areas of the Bakken.



BPOP 4.0 Key Takeaways...

Production Technology

- BPOP studies have assisted the members in critical decisions regarding crude oil vapor pressure, facility operations, and changing gas oil ratios. EERC experts continue to work with emerging artificial lift technologies. As an example, innovative technology to optimize of gas lift has been presented to members and is under consideration for a field pilot.



BPOP

Expect Results



**Increase productivity of
Bakken resources**



Decrease carbon intensity



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A wide-angle photograph of a university campus during autumn. In the foreground, there is a green lawn. Several trees with yellow and orange leaves are scattered across the scene. In the background, there are several large, multi-story brick buildings, likely university halls or research facilities. The sky is clear and blue. The sun is visible on the left side, partially obscured by a tree, creating a warm glow.

THANK YOU

Critical Challenges. Practical Solutions.

APPENDIX B

OIL PRODUCTIVITY AND GEOGRAPHIC EXTENT OF BPOP PARTNER OPERATIONS

OIL PRODUCTIVITY AND GEOGRAPHIC EXTENT OF BPOP PARTNER OPERATIONS

The bar graph in Figure B-1 shows the top 20 operators in North Dakota in terms of daily oil production. Bakken Production Optimization Program (BPOP) 5.0 anticipated partners include five operators out of the top ten oil producers. The maps in Figures B-2 and B-3 show the geographic distribution of the BPOP partners well locations, illustrating the fact that BPOP partnership spans a vast majority of the Bakken play in North Dakota. The BPOP partners also represent a diversity of company sizes, ranging from globally operating supermajors to companies for which the Bakken is the primary asset. This diversity within the partnership ensures that the views and needs of a wide variety of operators are served, fostering innovation, knowledge sharing, and broad applicability of results. The Energy & Environmental Research Center will actively recruit new partners and seek to grow the value of the program.

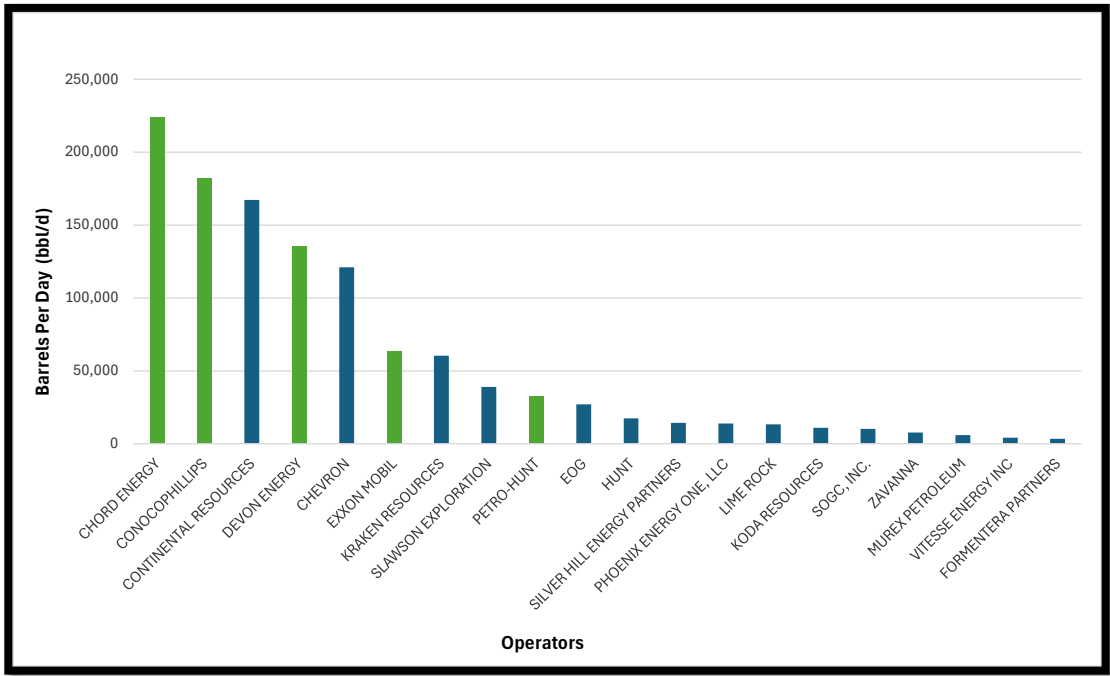


Figure B-1. Top 20 operators in North Dakota. BPOP partners are highlighted in green.

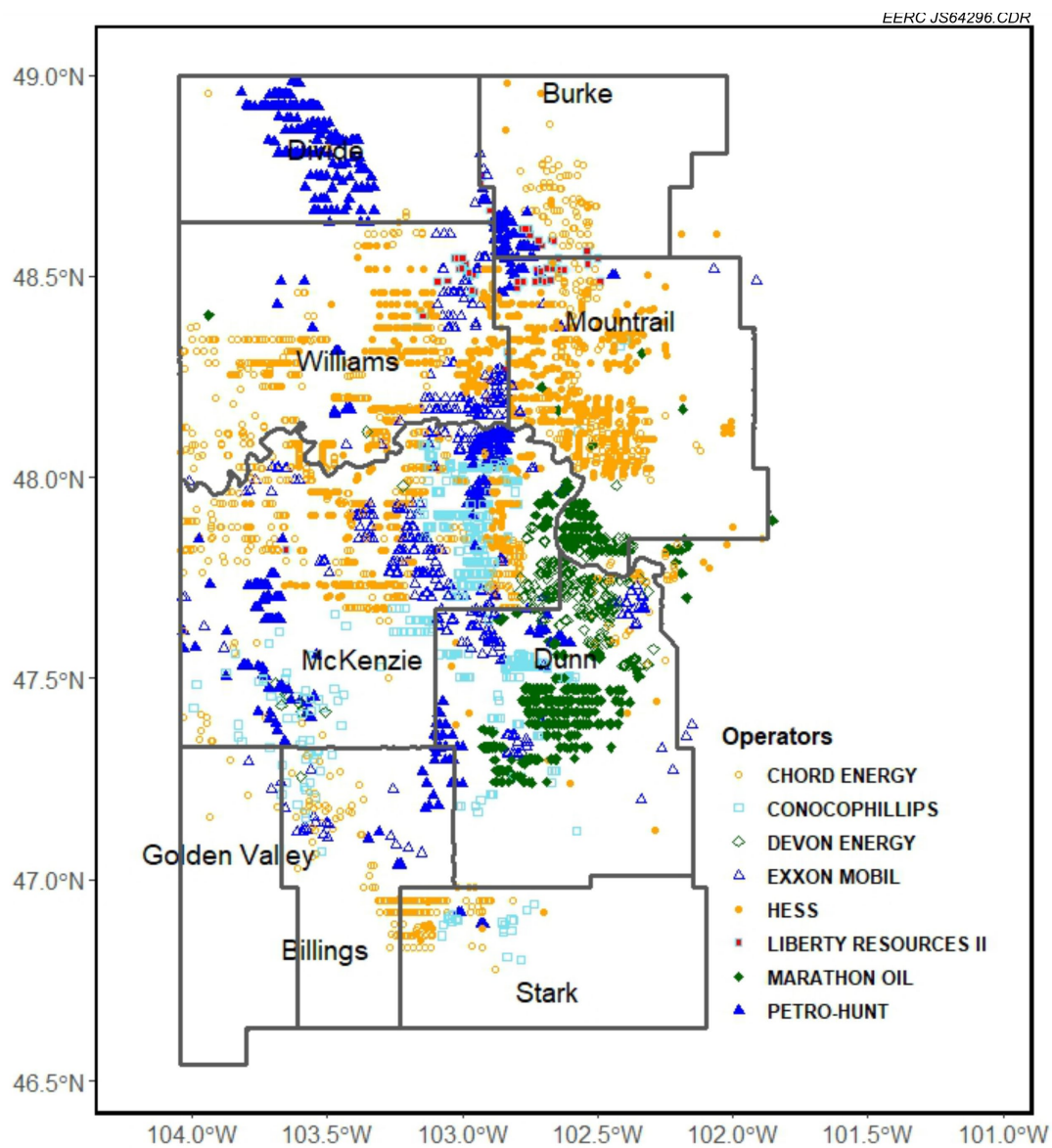
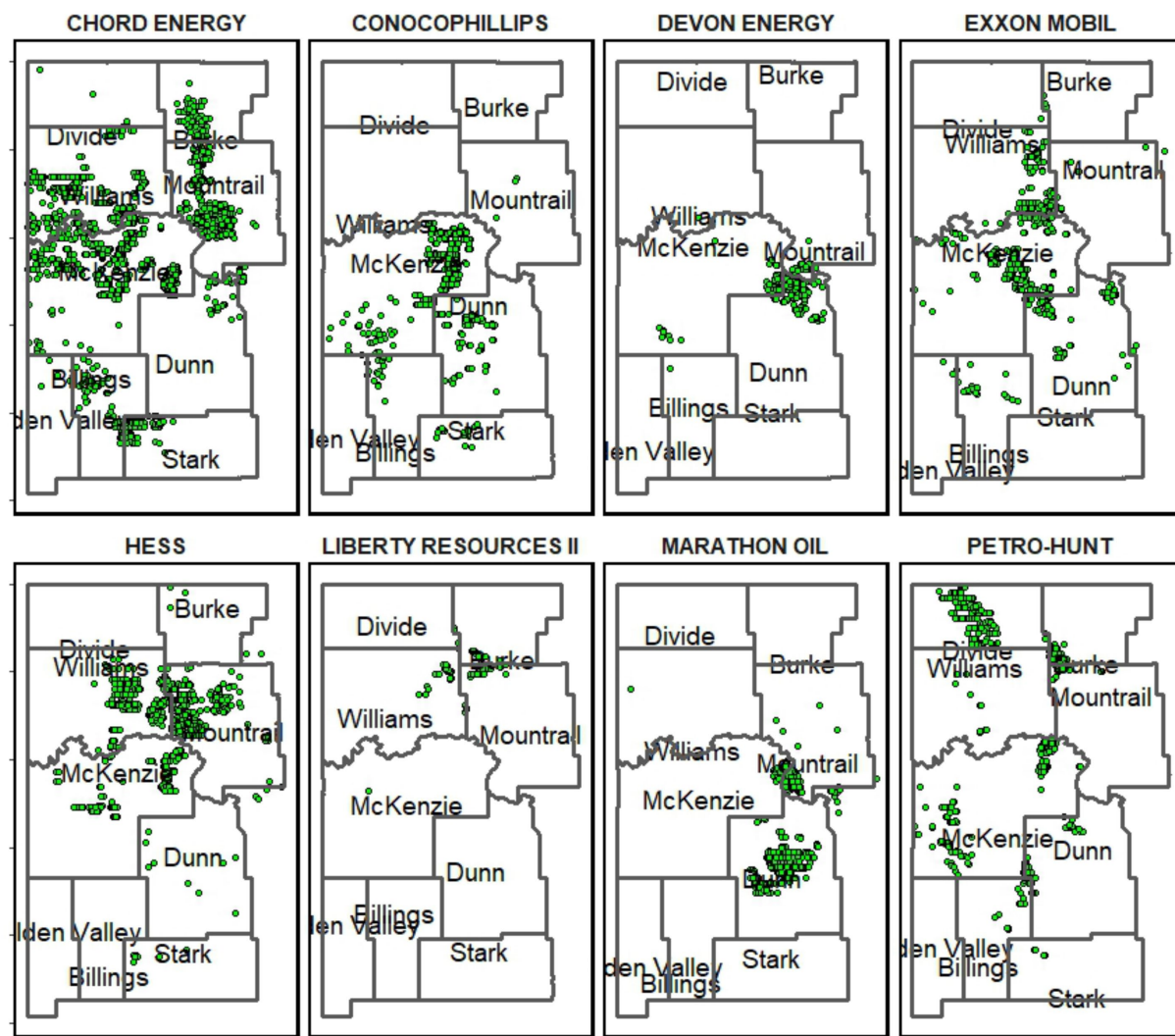


Figure B-2. Map showing geographic distribution of BPOP partner well locations.



EERC JS64297.CDR

Figure B-3. Maps of well locations for each of the BPOP partners.

APPENDIX C

RESUMES OF KEY PERSONNEL



JAMES A. SORENSEN

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

Education and Training

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

Research and Professional Experience

October 2019–Present: Director of Subsurface Research and Development, EERC, UND.
Responsible for developing and managing programs and projects focused on conventional, unconventional, and enhanced oil and gas production; the geological storage of CO₂; and other energy and environmental research.
Primary areas of interest and expertise are enhanced oil recovery (EOR) in unconventional tight oil formations, CO₂ utilization and storage in geologic formations, and tight oil resource assessment and development.

July 2018–September 2019: Assistant Director for Subsurface Strategies, EERC, UND.
Developed business opportunities, provided technical support and guidance regarding emerging areas of research, and served as a principal investigator (PI) and task manager for projects related to the sequestration of CO₂ in geologic media and the sustainable development of tight oil resources.

1999–July 2018: Principal Geologist, EERC, UND.
Served as manager and co-PI for programs to develop strategies for CO₂ utilization and storage.
Led research focused on EOR in the Bakken.

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

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

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

Professional Activities

Member, Society of Petroleum Engineers

Publications

Has coauthored nearly 200 publications.



DR. JOHN A. HARJU

Vice President for Strategic Partnerships

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

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701.777.5157, jharju@undeerc.org

Education and Training

Ph.D., Petroleum Engineering, University of North Dakota, 2022.

M.Eng., Petroleum Engineering, University of North Dakota, 2020.

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

Research and Professional Experience

2002–Present: EERC, UND.

July 2015–Present: Vice President for Strategic Partnerships. Harju leads efforts to build and grow dynamic working relationships with industry, government, and research entities globally in support of the EERC's mission to provide practical, pioneering solutions to the world's energy and environmental challenges. Harju represents the EERC regionally, nationally, and internationally in advancing its core research priorities: coal utilization and emissions, carbon management, oil and gas, alternative fuels and renewable energy, and energy–water. Harju's principal areas of interest and expertise include carbon sequestration, enhanced oil recovery, unconventional oil and gas development, waste management, geochemistry, technology development, hydrology, and analytical chemistry, especially as applied to the upstream oil and gas industry.

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

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

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

1999–2002: Vice President, Crystal Solutions, LLC, Laramie, Wyoming. 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. Harju developed and deployed produced water management technologies and methodologies for cost-effective and environmentally responsible management of oil and gas produced water.

1998–2000: Program Team Leader, Soil, Water, and Waste. Harju managed projects and programs related to the development of environmental technologies and informational products related to the North American oil and gas industry; formulated RFPs, reviewed proposals, and formulated contracts;

performed technology transfer activities; and supervised staff and contractors. Harju served as Manager of the Environmentally Acceptable Endpoints project, a multiyear program focused on rigorous determination of appropriate cleanup levels for hydrocarbons and other energy-derived contaminants in soils. Harju led GRI/GTI involvement with industry environmental consortia and organizations, such as PERF, SPE, AGA, IPEC, and API.

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

1988–1996: EERC, UND.

1994–1996: Senior Research Manager, Oil and Gas Group. Harju served as:

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

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

Professional Activities

Member, National Coal Council (appointed 2018)

Member, National Petroleum Council (appointed 2010)

Member, Mainstream Investors, LLC, Board of Governors (2014–present)

Member, DOE Unconventional Resources Technology Advisory Committee (2012–2014)

Member, Interstate Oil and Gas Compact Commission (appointed 2010)

Member, Rocky Mountain Association of Geologists

Publications

Harju has authored or coauthored more than 100 professional publications and nearly 300 technical presentations.



BETHANY A. KURZ

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

Education and Training

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

Research and Professional Experience

May 2021–Present: Director of Subsurface Characterization and Data Analytics, EERC, UND.

- Identifies and develops business and research opportunities to address challenges in all areas of energy and natural resources development and management.
- Leads programs, projects, and a multidisciplinary team of scientists and engineers in topics related to carbon capture, utilization, and storage (CCUS); application of machine learning and artificial intelligence to oil and gas production optimization and energy development; evaluation and application of enhanced oil recovery (EOR) strategies for conventional and unconventional reservoirs; produced water and drilling waste management; critical materials resource assessments; and public education and outreach.
- Leads the EERC's research laboratories and a multidisciplinary team of scientists and engineers focused on addressing the needs of our partners and clients in areas related to energy development and environmental stewardship.

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

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

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

- Research activities included the evaluation of water supply sources for the oil and gas industry, produced water management, characterization of geologic media for carbon storage, and development and testing of proppants for use in hydraulic fracturing.
- Oversaw a multidisciplinary team of scientists and engineers and several EERC analytical research laboratories that focus on classical and advanced wet-chemistry analyses; petrochemical, geochemical and geomechanical evaluation of rocks and soils; and advanced characterization of various materials, including metals, alloys, catalysts, and corrosion and scale products.

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

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

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

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

Publications

Has coauthored numerous professional publications.



DARREN D. SCHMIDT

Assistant Director for Energy, Oil, and Gas
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5201, dschmidt@undeerc.org

Education and Training

B.S., Mechanical Engineering, West Virginia University, 1994.
Registered Professional Engineer (Mechanical and Petroleum).

Research and Professional Experience

February 2021–Present: Assistant Director for Energy, Oil, and Gas, EERC, UND.

- Leads a team focused on research, development, and commercialization related to efficient and clean fossil fuel production, utilization, carbon management, and alternative fuels and renewable energy.

Principal areas of interest and expertise include oil and gas facilities, production, injection, well stimulation, enhanced recovery, power generation, and renewable technologies.

2016–January 2021: Principal Engineer, Research and Technology, Equinor, Williston, North Dakota.

- Provided leadership for Equinor’s research portfolio in Bakken/Williston Basin, with focus on low carbon.
- Developed project focused on reducing flaring in which patent application was filed.
- Earlier work included leading team to develop CO₂ used in well stimulations.
- Through Equinor’s involvement with North Dakota Oil and Gas Research Program, research was completed to address requirements surrounding crude oil vapor pressure.
- Worked closely with Equinor’s Williston office regional manager to support operations, including serving as regulatory liaison for emergency response team.

2013–2016: Completions Engineer, Statoil Completions, Williston, North Dakota.

- Served as completions engineer for Williams County, with strong focus on safe operations.
- Led successful program in 2015 to use 10% produced water in Statoil hydraulic fracturing operations.
- Oversaw hydraulic fracture designs, quality of operations, implementing new procedures, enforcing standard operating procedures, and approving fieldwork.
- Mentored interns and completions-related research projects to improve performance.

2012–2013: Technical Advisor, Weatherford Fracturing Technologies, Williston, North Dakota.

- Provided leadership to Williston district to ensure job quality, safety, personnel management, education, and training.
- Supported revenue; provided intelligence; conducted marketing; provided urgent response to customers, field services, and client-based technical assistance; and ensured quality reporting.
- Provided technical guidance to district stimulation fluids laboratory.

2008–2012: Senior Research Advisor, EERC, UND.

- Oversaw procurement and execution of research projects related to Bakken Formation in Williston Basin. Projects included utilization of associated gas in drilling operations, laboratory investigation of conductivity associated with proppants, fracturing fluids, and rock formations, enhanced production from coal bed methane, geologic storage of CO₂, and oil-field drilling, production, and workover operations.
- Served as advisor to distributed biomass gasification development and contributed to organization's revenue through research proposals, publications, and intellectual property.

1998–2008: Research Manager, EERC, UND.

- Secured research contracts, managed projects, and performed engineering tasks in the areas of cofiring and biomass power systems, including combustion, fluidized-bed, gasification, microturbine, and internal combustion engine generators; energy efficiency; ground-source heat pumps; hydrogen production from biomass; and researching the behavior of biomass in combustion systems relative to ash fouling and trace elements.

1994–1998: Mechanical Engineer, Research Triangle Institute (RTI), Research Triangle Park, North Carolina.

- Served as project leader for \$3M Cooperative Agreement with U.S. Environmental Protection Agency (EPA) to demonstrate electricity production using 1-MW wood gasification technology.
- Significant experience included permit, design, installation, operations, and reporting.
- Other activities included support of marketing activities and coauthoring publications.

Summer 1993: Internship, EERC, UND, Grand Forks, ND.

- Supported combustion and coal ash studies.

Summer 1992: Internship, Foster Wheeler Development Corporation, Livingston, New Jersey.

- Supported gasification research and development.

Professional Activities

Appointed Member, North Dakota Oil and Gas Research Council
Cochair, North Dakota Petroleum Council Technology Solutions Group
Section Chair, Williston Basin Society of Petroleum Engineers

Publications

Has authored or coauthored over 80 peer-reviewed and other professional publications.

Patents

Method and Apparatus for Supply of Low-Btu Gas to an Engine Generator. U.S. Patent 8,460,413, June 11, 2013.

Application of Microturbines to Control Emissions from Associated Gas. U.S. Patent 8,418,457, April 16, 2013.

Hydrocarbon Gas Recovery Methods. U.K. Application No. 2009516.2, filed June 22, 2020.



DR. NICHOLAS A. AZZOLINA

Assistant Director for Applied Data Analytics
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5120, nazzolina@undeerc.org

Education and Training

Ph.D., Environmental Management and Science, Carnegie Mellon University, 2015.
M.S., Hydrogeology, Syracuse University, 2005.
B.A., Geological and Geophysical Sciences, Princeton University, 1997.

Research and Professional Experience

September 2021–Present: Assistant Director for Applied Data Analytics, EERC, UND.

- Hydrogeologist and statistician with over 25 years of industrial and consulting experience, specializing in analyzing and modeling large, complex environmental datasets.
- Manages technical staff and supports projects across the EERC's Subsurface Group, requiring machine learning, statistics, and data analytics expertise. Example research areas and projects include i) carbon dioxide (CO₂) management through carbon capture, utilization, and storage (CCUS); ii) oil and gas production from conventional and unconventional reservoirs; iii) water resource options for the energy industry, iv) risk assessments for CCUS and other subsurface projects, and v) life cycle analyses (LCAs) for CCUS and other subsurface projects.

December 2016–September 2021: Principal Hydrogeologist and Statistician, EERC, UND.

- Supported various projects related to CO₂ enhanced oil recovery (EOR), CCUS, unconventional oil and gas production, and chemical contamination of environmental media (soil, groundwater, and sediment).
- Conducted LCAs and risk assessments for CCUS and other subsurface projects.

2010–2017: Independent Consultant, The CETER Group, Inc.

2008–2010: Scientist/Project Manager, Foth, Green Bay, Wisconsin.

2005–2008: Scientist/Project Manager, The RETEC Group, Inc., Ithaca, New York.

2004–2005: Scientist, O'Brien and Gere Engineers, Inc., Syracuse, New York.

2003–2005: Research Assistant/Head Teaching Assistant, Syracuse University, Department of Earth Science, Syracuse, New York.

2000–2003: Supervisor, McMaster-Carr Supply Co., Dayton, New Jersey.

1997–2000: Senior Field Engineer, Schlumberger Oilfield Services, Edinburg, Texas.

Publications

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



DR. LU JIN

Distinguished Reservoir Engineer

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

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

701.777.5316, ljin@undeerc.org

Education and Training

Ph.D., Petroleum Engineering, Louisiana State University, 2013.

M.S., Petroleum Engineering, Louisiana State University, 2009.

B.S., Petroleum Engineering, Northeast Petroleum University, 2005.

Research and Professional Experience

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

- Develops novel methods for renewable energy development in Williston Basin, including geothermal development in Bakken Formation and hydrogen conversion in oil reservoirs.
- Leads scientific research activities on machine learning applications, enhanced oil recovery (EOR) technologies, database development for EOR operations, effective simulation methods for unconventional reservoirs, etc.
- Serves as task lead and key reservoir engineer for U.S. Department of Energy (DOE)-sponsored project, “Williston Basin Resource Study for Commercial-Scale Subsurface Hydrogen Storage.”
- Serves as principal investigator (PI) for North Dakota Industrial Commission (NDIC)-sponsored project, “Extending the Shale Revolution from Oil and Gas to Geothermal Development in North Dakota.”
- Serves as PI for NDIC-sponsored project, “Examination of In Situ Hydrogen Conversion in Oil Reservoirs.”
- Serves as task lead and key reservoir engineer for U.S. Department of Energy (DOE)-sponsored project, “CO₂ Enhanced Oil Recovery Improvement in Conventional Fields Using Rich Gas.”
- Serves as task lead and key reservoir engineer for DOE-sponsored project, “Improving Enhanced Oil Recovery Performance Through Data Analytics and Next-Generation Controllable Completions.”
- Serves as task lead and key reservoir engineer for NDIC-sponsored project, “Unitized Legacy Oil Fields: Prototypes for Revitalizing Conventional Oil Fields in North Dakota.”

Principal areas of interest and expertise include reservoir modeling and simulation, CO₂/rich gas EOR and associated CO₂ storage in both conventional and unconventional reservoirs, engineering optimization, water coning control, and multiphase flow in porous media, with particular interest in subsurface oil–water–gas interactions, EOR techniques and development of old oil fields/unconventional resources.

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

- Developed dynamic numerical models for CO₂/rich gas enhanced oil recovery in different reservoirs.
- Oversaw technical areas in reservoir engineering, including conventional, unconventional and enhanced oil and gas production, geologic storage of CO₂ and natural gas, natural resource development, geocellular modeling, numerical simulation.

- Served as task lead and key reservoir engineer for DOE-sponsored project, “CO₂ Enhanced Oil Recovery Improvement in Conventional Fields Using Rich Gas.”
- Served as task lead and key reservoir engineer for DOE-sponsored project, “Improving Enhanced Oil Recovery Performance Through Data Analytics and Next-Generation Controllable Completions.”
- Served as key reservoir engineer for DOE-sponsored project, “Bakken Rich Gas Enhanced Oil Recovery Project.”
- Served as co-PI for NDIC-sponsored project, “Exploration of Opportunities and Challenges for a North Dakota Petrochemical Industry.”

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

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

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

- Developed geophysical models of subsurface and ran dynamic simulations to determine long-term fate of produced/injected fluids, including hydrocarbons, CO₂ storage, and brine, using oil and gas industry simulation software.
- Served as task lead and key reservoir engineer for DOE-sponsored project, “Plains CO₂ Reduction (PCOR) Partnership Phase III – Bell Creek Test Site.”
- Served as Co-PI and key reservoir engineer for DOE-sponsored project, “Improved Characterization and Modeling of Tight Oil Formations for CO₂ Enhanced Oil Recovery Potential and Storage Capacity Estimation.”
- Served as key reservoir engineer for DOE-sponsored project, “Scalable, Automated, Semi-permanent Seismic Method for Detecting CO₂ Plume Extent During Geological CO₂ Injection – Phase I.”

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

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

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

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

January 2013–December 2013: Reservoir Consultant, Joint Industrial Program (JIP), LSU, and Pluspetrol, Baton Rouge, Louisiana. Simulated cold production of heavy oil in Massambala Field, Angola, identifying mechanisms of high water cut in current wells, optimizing perforation length for conventional wells, and proposing two well systems, which could improve cumulative oil up to 80% or reduce produced water 75%, respectively.

May 2012–August 2012: Internship, High Plains Operating Company, LLC (HPOC), San Francisco, California. Simulated and analyzed extra water production problems in Ojo Encino Field, New Mexico, designing DWS well system to produce oil from thick transition zone, which could improve oil production rate by up to 20%.

May 2011–August 2011: Internship, JIP, LSU, and HPOC, Baton Rouge, Louisiana. Simulated performance of vertical and horizontal wells in Ojo Encino Field, New Mexico, diagnosing water coning/cresting problems in thick transition zone, determining best location for water injection to minimize pressure interference, and suggesting well type to develop field, which saved costs up to 30%.

January 2011–January 2013: Senior Teaching Assistant, Drilling Fluids Laboratory, LSU, Baton Rouge, Louisiana. Served as lecturer and oversaw four teaching assistants and 80–100 students each year as well as supervised three senior students completing their senior design projects.

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

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

Professional Activities

Member, Society of Petroleum Engineers

Publications

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



MATTHEW L. BELOBRAYDIC

Assistant Director for Geoscience

Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5030, mbelobraydic@undeerc.org

Education and Training

M.S., Geology, Ball State University, 2006. Thesis: "Drainage Basin Analysis and Fluvial Geomorphic Reconstruction Plan for the Killbuck–Mud Creek Subwatershed, Delaware County, Indiana."

B.S., Geology, University of Idaho, 2003. Senior Project: "Drainage Analysis for Colfax South, Diamond, Dusty, Thera, Thornton Quadrangles and an Experimental Quadrangle of Eastern Washington."

Research and Professional Experience

2022–Present: Assistant Director for Geoscience, EERC, UND.

- Collaborates with EERC subject matter experts, principal investigators, and leadership to prepare proposals and pursue new business opportunities and leads and manages projects in the areas of enhanced oil recovery (EOR) in conventional and unconventional formations, CO₂ and produced gas storage, natural resource management, critical materials resource characterization and recovery, geologic and synthetic materials characterization, produced water management, and the environmental aspects of energy development.
- Manages a team of petrophysicists and subsurface data management professionals.
- Coaches and mentors more than ten geoscientists in geology, stratigraphy, geostatistical, geologic modeling, and uncertainty methods.
- Develops strategic plans for petrophysical products and data-handling procedures for subsurface teams.
- Assists the Director of Analytical Solutions by providing business directions for technical reports and technical expertise.
- Creates project proposals and maintains client relationships.

Principal areas of interest and expertise include stratigraphic and structural interpretations, geologic characterization, data science, process automation, geostatistical analysis, geomodeling, and uncertainty analysis.

December 2020–2022: Principal Geoscientist, Geoscience and Engineering Group, EERC, UND.

- Collaborated with EERC subject matter experts and principal investigators to create geological interpretations and prepared proposals in the areas of EOR in conventional and unconventional formations, CO₂ and produced gas storage, natural resource management, geologic materials characterization, produced water management, and environmental aspects of energy development.
- Mentored geoscientists as subject matter expert in geology and geologic modeling for more than ten federal, state, and private contracts.
- Coached modeling team members through team-building and workflow improvement exercises.
- Characterized reservoirs and depositional environments for projects to maximize subsurface understanding and minimize development risk.

- Managed resources, budgets, and timelines on projects to successfully complete within deadlines and scope.

October 2020 – December 2020: Temporary Geoscientist, EERC, UND.

- Produced geology and geological modeling results for CO₂ storage projects as part of an integrated team of EERC subject matter experts.
- Produced 3D geologic models for CO₂ storage for select clastic formation within the Williston Basin.
- Coached three geoscientists through geostatistical and geomodeling methods as on-the-job training.

September 2008–April 2020: Senior III Reservoir Geologist, SLB, Denver, Colorado.

- Produced data-driven client solutions as part of a multidisciplinary consulting team, improving internal technical processes and workflows to increase efficiency and maximize profits.
- Managed team of petrophysicist, geophysicist, geologist, and reservoir engineers from proposal to project close as technical lead for more than ten client projects.
- Introduced Agile and Scrum project management to local consulting team, changing work processes, shortening turnaround times by 66% and increasing bottom line.
- Reviewed green energy workflows and processes for internal geothermal and carbon capture and storage teams as subject matter expert to mitigate risk and uncertainty.
- Initialized and maintained backlog for basin interpretation cloud subscription service as Scrum product owner to capture previously inaccessible market share.
- Adapted working style and deliverables to become trusted technical advisor for more than 20 client organizations, each with unique business priorities.
- Coordinated stakeholders and potential clients for four cloud subscription service offerings to maximize value, drive communication, and quantify feedback of results.
- Created harmonious and integrated team environments for technical staff from both Schlumberger and client organizations for project collaborations.
- Characterized petroleum systems and depositional environments for client acreage to maximize reservoir understanding and minimize development risk.
- Interpreted structure and stratigraphy for full 3D models, combining seismic data for conventional and unconventional plays in more than ten basins and 30 fields globally.
- Analyzed raw and interpreted data to generate geostatistically accurate static reservoir models in Petrel on more than five projects per year for worldwide clients.
- Published and automated uncertainty optimization technique, reducing dynamic simulation iterations by 80% and generating a positive feedback loop to initial inputs.
- Built custom Python, SQL, and Petrel workflows, increasing productivity by up to 900%.
- Coached and mentored more than 30 individuals through organized team-building activities and formal career development.
- Created advanced modeling curriculum and training programs in Petrel for more than 25 junior geoscientists.
- Published results and methodologies for select client work as posters and papers to technical conferences and professional societies.
- Requested presenter to professional societies for geology, data science, and machine learning.
- Prepared and reviewed proposals, reports, and project documentation, effectively communicating technical results and methodology to clients and working teams.

September 2006–August 2008: CO₂ Enhanced Oil Recovery Research Assistant, UND.

- Researched CO₂ enhanced oil recovery and sequestration potential for the Williston Basin alongside the EERC.
- Generated systematic approach for assessing enhanced oil recovery and carbon dioxide sequestration for fields of interest.
- Produced 3D reservoir models to simulate enhanced oil recovery and carbon dioxide sequestration potential.

May 2005–May 2006: National Science Foundation GK–12 Fellow, Ball State University, Muncie, Indiana.

- Provided in-classroom support to Indianapolis Public Schools (IPS) teachers through inquiry-based lessons and assisted in professional development for K–8 science standards.
- Developed middle school Earth science curriculum and lessons for IPS.
- Provided aid in the professional development of IPS teachers as a knowledge resource.

Professional Activities

Member, American Association of Petroleum Geologists

Member, Rocky Mountain Association of Geologists

Publications

Has authored or coauthored numerous professional publications.

APPENDIX D

LETTERS OF COMMITMENT



April 19, 2024

SENT VIA ELECTRONIC MAIL

University of North Dakota
Attn: Sheryl Eicholz-Landis
slandis@undeerc.org

SUBJECT: Selection of Application for Negotiation Under Funding Opportunity
Announcement Number DE-FOA-0003015, Enabling a Reduced Carbon
Footprint for Carbon Dioxide Enhanced Oil Recovery (CO₂-EOR)/Storage
Field Test Sites in Unconventional Reservoirs

Dear Sheryl Eicholz-Landis:

We are pleased to provide this update on your application. The Office of Fossil Energy and Carbon Management within the Department of Energy (DOE) has completed its evaluation of your application submitted in response to the subject Funding Opportunity Announcement (FOA). The application below has been recommended by the Office of Fossil Energy and Carbon Management negotiation of a financial award (Note: This notification does not guarantee Federal Government funding, as funding will only be obligated upon completion of successful negotiations.):

Application: Bakken Carbon Dioxide Enhanced Oil Recovery and Storage Field
Laboratory
Principal Investigator: James Sorensen
Application Control Number: GRANT14050970

DOE has embargoed any public announcement of your selection until further notice. You must refrain from making any public announcements – through press releases, social media, or any other public communication platform – until DOE has made the selection announcement. At the time of the announcement, we will provide you with a link to the announcement and inform you that the embargo has officially been lifted via subsequent email. You will then be free (and encouraged) to announce your selection for negotiation leading to an award publicly.

Receipt of this letter does not authorize you to commence with performance of the project. DOE makes no commitment to issue an award and assumes no financial obligation with the issuance of this letter. Applicants do not receive an award until award negotiations are complete and the Contracting Officer executes the funding agreement. Only an award document signed by the Contracting Officer obligates DOE to support a project.

The award negotiation process may take up to 90 days. You must be responsive during award negotiations (i.e., provide requested documentation) and meet the stated negotiation deadlines. Failure to submit the requested information and forms by the stated

due date, or any failure to conduct award negotiations in a timely and responsive manner, may cause DOE to cancel award negotiations and rescind this selection. DOE reserves the right to terminate award negotiations at any time for any reason.

Please complete the following items and submit to DOE no later than May 3, 2024:

- Pre-Award Information Sheet (available at <https://www.netl.doe.gov/business/business-forms/financial-assistance>)

If your organization, including any subrecipient or contractor, anticipates involving foreign nationals (FNs) in the performance of the award, your organization is required to provide a list of all FNs planned to participate on the award along with basic information about each. You must download and complete the “Foreign National Participation Document” located at <https://www.netl.doe.gov/business/business-forms/financial-assistance> under Post Selection Forms/Information and submit the completed document to basicinfo@netl.doe.gov with a courtesy copy to the assigned Project Manager (PM) and Grants Management Specialist.

Upon receipt of the completed “Foreign National Participation Document,” we will create a secured file sharing drop box folder(s) for **FNs in Principal Investigator (PI)/Co-PI roles and for FNs from countries identified on the U.S. Department of State’s list of State Sponsors of Terrorism** located at <https://www.state.gov/state-sponsors-of-terrorism/> for submission of additional information. The additional information will NOT be required for any of the other FNs planned to participate on the award, and therefore, a folder(s) will not be created.

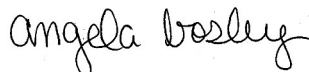
As part of the requirement to submit additional information for PIs/Co-PIs and for FNs from countries identified as State Sponsors of Terrorism, your organization must ensure completion of the “Foreign National Participation **Data** Document” also located at <https://www.netl.doe.gov/business/business-forms/financial-assistance>. The document and all required attachments must be uploaded to the secured file sharing drop box folder(s) provided by DOE’s FN Request Coordinator. The assigned PM will contact the appropriate FN Data Entry POC in the event there are issues with the submission.

Please note that all FNs identified on the “Foreign National Participation Document,” **except for FNs from countries identified on the U.S. Department of State’s list of State Sponsors of Terrorism,** are authorized to commence work as of the award effective date unless determined otherwise by DOE. FNs from countries identified on the U.S. Department of State’s list of State Sponsors of Terrorism are **NOT** permitted to participate on the award until written authorization is received from the Contracting Officer.

The Contracting Officer will notify your organization of DOE’s decision regarding participation of FNs from countries identified on the U.S. Department of State’s list of State Sponsors of Terrorism. The DOE reserves the right to request additional information or deny participation of any FN at any time.

Please provide the requested documents to the attention of Davina Reed, who is the Grants Management Specialist from the Finance and Acquisition Center handling the administrative portion of your application. Davina Reed can be reached at (412)-386-9199 or davina.reed@netl.doe.gov. Joseph Renk is the DOE Project Manager from the Project Management Division handling the technical portion of your application and can be reached at (412)-386-6406 or joseph.renk@netl.doe.gov.

Sincerely,

A handwritten signature in black ink that reads "Angela Bosley". The signature is written in a cursive, flowing style.

Angela Bosley
Contracting Officer
Finance and Acquisition Center

cc: FOA File
Basicinfo@netl.doe.gov
jsorensen@undeerc.org
joseph.renk@netl.doe.gov
Davina.reed@netl.doe.gov

January 23, 2024

Mr. Charles Gorecki
CEO
Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018



Subject: Support for EERC proposal to US Department of Energy funding opportunity announcement
"Enabling a Reduced Carbon Footprint for Carbon Dioxide Enhanced Oil Recovery/Storage Field Test Sites
in Unconventional Reservoirs (DE-FOA-0003015)"

Dear Mr. Gorecki,

Chord Energy supports the Energy & Environmental Research Center's (EERC) application to secure funding from the U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management to advance enhanced oil recovery (EOR) and carbon dioxide (CO₂) storage in unconventional oil reservoirs of the Bakken Formation. Chord Energy is one of the top oil producers in the Bakken play, with over 3,800 wells producing over 165,000 bbls oil/day in North Dakota and Montana. As the proposed operator for the EERC's proposed Bakken CO₂ Enhanced Oil Recovery and Storage Project, Chord Energy would be, as outlined in this letter, willing to provide in-kind cost-share contributions which may include, but are not necessarily limited to, the following:

- Access to horizontal wells that may be used for injection of CO₂ and offset monitoring.
- Procurement of CO₂ for injection operations.
- Installation, operation, and maintenance of infrastructure necessary to support CO₂ injection.
- Operation of all injection and reservoir surveillance activities.
- Access to unique reservoir fluid and/or core samples.
- Collection of reservoir surveillance and diagnostics data.
- Technical support services in the design and execution of the pilot and interpretation of results.
- It is estimated that the value of those contributions will be a minimum of \$2,900,000.

Chord Energy maintains sustainable energy practices that exemplify our commitment to energy security. Our environmental, social, and governance (ESG) approach demonstrates our ongoing commitment to creating a resilient and prosperous world. We view the advancement of CO₂ capture from industrial sources and injection for the purpose of EOR and geologic storage of CO₂ to be a method for advancing our sustainability and ESG goals. Chord Energy is committed to the submission of this proposal by the EERC, and if selected for award by DOE, would be excited to have the opportunity to work on the proposed project, subject to mutually acceptable timing, costs, funding, and other material terms.

Sincerely,

A handwritten signature in blue ink that reads "Michael King". The signature is fluid and cursive, with the first name "Michael" and last name "King" clearly distinguishable.

Michael King
Vice President of Asset Management



1001 Fannin Street, Suite 1500
Houston, TX 77002
O 281.404.9500
F 281.404.9501

August 14, 2025

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

Dear Dr. Harju:

Chord Energy LLC (Chord) strongly supports the Energy & Environmental Research Center's (EERC's) continued collaboration with the State of North Dakota, the petroleum industry, and the U.S. Department of Energy (DOE) to address key challenges in the Bakken. We are pleased to support the EERC's proposal for Bakken Production Optimization Program (BPOP) 5.0. Since joining BPOP in 2020, Chord has remained committed to advancing practical, research-driven solutions for the Bakken. We are particularly invested in the development and deployment of enhanced oil recovery (EOR) technologies, which hold the potential to unlock otherwise unrecoverable oil.

Chord is currently collaborating with the EERC under a DOE Office of Fossil Energy and Carbon Management funded project focused on advancing EOR in unconventional oil reservoirs (DE-FE0032514). This ongoing effort directly supports BPOP 5.0 goals and objectives. The DOE-funded project will provide cost share to the BPOP 5.0 North Dakota Industrial Commission (NDIC) proposal, further aligning state, federal, and industry priorities.

As part of the BPOP 5.0 effort, Chord is committed to working closely with the EERC to perform robust laboratory, modeling, and field injection activities to demonstrate the potential for Bakken EOR and support the broader goal of transitioning from pilot testing to commercial scale deployment. We anticipate showing a minimum of \$380,000 of in-kind cost-share in the form of technical staff labor and/or field labor over the duration of the BPOP 5.0 program. We value our continued partnership with the EERC and remain committed to supporting research that enhances resource recovery, improves efficiency, and ensures responsible energy development in North Dakota.

Sincerely,

A handwritten signature in black ink, appearing to read "A. Buck", written in a cursive style.

Arvo Q. Buck
Director – New Ventures



August 12, 2025

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

Subject: Advanced Flow Solutions – Letter of Support for the Project Entitled “Bakken Production Optimization Program (BPOP) 5.0”

Dear Dr. Harju:

Advanced Flow Solutions (AFS) supports the Energy & Environmental Research Center’s (EERC) proposed Bakken Production Optimization Program (BPOP) 5.0. The program provides value to operators and service providers working in the Bakken. We are pleased with BPOP’s focus on reducing flaring and efforts to develop new technology.

AFS appreciates the EERC’s continued leadership in bringing scientifically proven practical solutions to the oil field. We look forward to continued engagement with EERC through the BPOP 5.0 effort.

Sincerely,

A handwritten signature in black ink, appearing to read "John Hays". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

John Hays
Business Line Leader – Pumps & Compressors

Main Office & Manufacturing
Advanced Flow Solutions
9201 North I-35 Service Road,
Oklahoma City, OK 73131
+1 (405) 946-5576
corken.com



August 14, 2025

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

Subject: Devon Energy Corp. – Letter of Support for the Project Entitled “Bakken Production Optimization Program (BPOP) 5.0”

Dear Dr. Harju:

Devon Energy strongly supports the EERC’s proposal to conduct a range of research activities as part of the Bakken Production Optimization Program (BPOP) 5.0. We recognize the value this longstanding program has brought to Bakken stakeholders. The BPOP consortium, led by the EERC, has a proven track record for developing practical knowledge and technical tools that optimize oil production and enable continued sustainable development of Bakken resources. In particular, Devon Energy has great interest in EERC’s efforts under BPOP to advance Bakken EOR towards commercialization, develop innovative approaches to improved oil recovery, and apply the latest advances in artificial intelligence to improving the efficiency of Bakken operations, including benchmarking lease operating expenses across the play. We believe BPOP 5.0 will contribute to meaningful technical insights and help address key challenges facing operators across the play. We look forward to continued engagement with the EERC team and our fellow partners in this important initiative.

Sincerely,

A handwritten signature in black ink that reads "Bryan Bugg". The signature is fluid and cursive, with the first name "Bryan" and last name "Bugg" clearly distinguishable.

Director of Production, Facilities, and Infrastructure
Bryan Bugg



Petro-Hunt , L.L.C.

P.O. Box 935

Bismarck, ND 58502

Phone (701) 255-5666 Fax (701) 258-1562

Toll Free 888-224-8620

e-mail - jherman@petro-hunt.com

August 11, 2025

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

Subject: Petro-Hunt LLC – Letter of Support for the Project Entitled “Bakken Production Optimization Program (BPOP) 5.0”

Dear Dr. Harju:

Petro-Hunt LLC sincerely offers our support for the Energy & Environmental Research Center’s (EERC) proposed Bakken Production Optimization Program (BPOP) 5.0. Through our many years of previous participation in BPOP we have come to recognize the tremendous value that the EERC’s BPOP activities and results have provided to its industry and government partners. We have found the results of the research conducted by the EERC under BPOP to be invaluable to our understanding of how to get the most value out of the Bakken. In particular, we appreciate the practical results-focused webinars, in-person technical meetings, and web-based data analytical tools that are hallmarks of BPOP.

Petro-Hunt is excited to engage with the EERC through BPOP 5.0 over the coming years as they focus on increasing the ultimate recovery of Bakken resources through a wide variety of innovative activities. We appreciate the EERC’s goal of maintaining the Bakken’s status as a world class petroleum resource through effective, practical research and development. We look forward to continuing our relationship with EERC through participation in BPOP 5.0.

Sincerely,

Jeff Herman
Region Manager



August 12, 2025

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

Subject: Steffes – Letter of Support for the Project Entitled “Bakken Production Optimization Program (BPOP) 5.0”

Dear Dr. Harju:

Steffes wishes to express our support for the Energy & Environmental Research Center’s (EERC) proposed Bakken Production Optimization Program (BPOP) 5.0. We recognize the value of collaborative, data-driven research to advance the development and deployment of innovative emissions control technologies at Bakken oil production sites. We are proud to be a part of the state’s and industry’s efforts to bring long-term sustainability to the Bakken.

Steffes appreciates the EERC’s continued leadership in bringing scientifically proven practical solutions to the oil field. We look forward to continued engagement with EERC through the BPOP 5.0 effort.

Sincerely,

A handwritten signature in black ink, appearing to read 'Todd C. Mayer', written over a light blue horizontal line.

Todd C. Mayer, Co-President
Steffes, LLC

APPENDIX E

BUDGET NOTES

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). If 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 among budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only. The project manager may incur and allocate allowable project costs among the funding sources for this scope of work in accordance with Office of Management and Budget (OMB) Uniform Guidance 2 CFR 200.

Escalation of labor and EERC recharge center rates are 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 increase the budget. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

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

Fringe Benefits: Fringe benefits consist of two components, which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services. This portion of the rate covers vacation, holiday, and sick leave (VSL) and is applied to direct labor for permanent staff eligible for VSL benefits. Only the actual approved rate will be charged to the project. The second component is estimated based on historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

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

Equipment: Not applicable.

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.

Subrecipient – Chord Energy: Chord will be responsible for the following activities: CO₂ procurement, securing site access, pilot design and execution, reservoir surveillance data collection, permitting, and capital and operational expenditures for the surface facilities required to conduct field-based efforts.

Subcontract – Virginia Tech Applied Research Corporation: Dr. Maegen Nix serves as Director of the Decision Science Division at Virginia Tech's Applied Research Corporation and is an adjunct instructor of Global Security at the School of Public and International Affairs. She also holds leadership roles within the United States Naval Academy community, acting as Vice President of USNA Women, a 501(c)(3) nonprofit, and as a member of the USNA Alumni Association Board of Trustees. Dr. Nix will lend her extensive expertise in artificial intelligence and machine learning to the EERC, advising on the integration of AI/ML solutions into the data analytics workflows supporting the Bakken petroleum system.

Subcontract – Steffes Corporation: Steffes Corporation will be constructing the units, installing them, and contracting with the site operators for upkeep of the equipment, allowing the EERC to get the operations data for the project.

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. 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.

Rents and Leases – Flow Meter: Fee to rent the flow meter.

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

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

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

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

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

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

Technical software recharge fees cover a use fee for advanced project management tools. Costs are associated with software, data entry, maintenance, and enhancement of the system.

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

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

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

Outside lab – Gas sampling: Will be utilized to collect and analyze gas samples from the project sites.

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

Cost Share: Cash cost share is being provided in the form of annual partnership payments from BPOP partners. A total of \$1,200,000 is expected in cash from partners. In-kind cost share of \$380,000 will be provided by Chord Energy toward a commercial-scale EOR pilot in a Bakken drilling spacing unit. The U.S. Department of Energy will also provide \$4,450,206 of cash cost share.

APPENDIX F

STATUS OF ONGOING PROJECTS LIST

STATUS-OF-ONGOING-PROJECTS LIST

Project Name	Contract Award No.
BPOP 4.0 – Bakken Production Optimization Program 4.0	G-058-115
Breaking New Ground in Flaring Reduction	G-061-118
Improving EOR Performance Through Data Analytics and Next-Generation Controllable Completions	G-050-97
Injection Testing with Propane to Inform Future Bakken CO ₂ EOR Pilot	G-061-121
iPIPE: The intelligent Pipeline Integrity Program	G-046-88
iPIPE 3.0: The intelligent Pipeline Integrity Program	G-059-116
PCOR Partnership Initiative to Accelerate CCUS Deployment	G-050-96