

Technical Reviewers' Rating Summary

Proposal Number	G-62-I	Application Title	Bakken Production Optimiza	Submitted By
EERC	Request For	\$6,000,000.00	Total Project Costs	
\$12,030,206.00				

Section A. Scoring

Statement	Weighting Factor	G-62-I	G-62-I2	G-62-I3	Average Weighted Score
1. Objectives	9	5	5	2	36
2. Achievability	7	4	4	5	28
3. Methodology	8	4	5	3	32
4. Contribution	8	5	5	3	32
5. Awareness / Background	5	5	5	5	25
6. Project Management	3	3	5	3	9
7. Equipment / Facilities	2	4	3	2	6
8. Value / Industry - Budget	4	5	3	3	12
9. Financial Match - Budget	4	3	3	2	8
Average Weighted Score		219	223	159	200

Total: 50

250 possible points

OVERALL RECOMMENDATION

FUND	X	X	
FUNDING TO BE CONSIDERED			X
DO NOT FUND			

Section B. Ratings and Comments

1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Oil and Gas Research Council goals are:

The goals and objectives outlined in the latest BPOP proposal remain very consistent with the majority of the goals and purposes of the OGRC. The BPOP application aligns exceptionally well with the following goals, purposes, and objectives: • Promote efficient, economic, and environmentally sound exploration, development, and use of North Dakota's oil and gas resources. • Preserve and create jobs involved in the exploration, production and utilization of North Dakota's oil and gas resources. • Ensure economic stability, growth, and opportunity in the oil and gas industry • Encourage, and promote the use of new technologies and ideas that will have a positive economic and environmental impact on oil and gas exploration, development, and production in North Dakota. • Generate information and knowledge that will have the highest probability of bringing new oil and gas companies and industry investment to North Dakota. • Have the highest potential for creating new oil and gas jobs, wealth, and tax revenues for North Dakota. • Positively effect ultimate recovery from North Dakota's existing oil and gas pools. • Preserve existing jobs and production levels. • Identify oil and gas exploration and production technologies presently not used in North Dakota. • Develop baseline information that will lead to other projects, processes, ideas, and activities.

- Reviewer: G-62-I
- Rating: 5

The project goals of increased oil and gas recovery from the Bakken formation are in line with the NDIC/OGRC goals of increased business opportunities, economic benefits, tax revenues, and job creation within the state of North Dakota. The Bakken Production Optimization Program 5.0 is a continuation of a series of existing programs that have a proven track record, in that regard. As the Bakken formation moves into a mature reservoir development phase, the implementation of enhanced oil recovery (EOR) methods will be essential to sustaining economic oil and gas production, well into the future.

- Reviewer: G-62-I2
- Rating: 5

BPOP 5.0 is a continuation of 12 years of technical work that is well established however the presentation is simply reviewing what BPOP 4.0 accomplished and does not necessarily indicate what they intend to solve point-forward. With 12 years of continued partnership I assume this is clear, but to the layman the BPOP 5.0 goals are not obvious. The technical slides for previous work cover a huge swath of the industry so isn't clear which of those are the focus point-forward.

- Reviewer: G-62-I3
- Rating: 2

2. With the approach suggested and time and budget available, the objectives are:

Given the past 11 years of success outlined in the application, there are no legitimate concerns regarding the EERC team's ability to achieve the stated goals. OGRC members should be able to readily assess whether the results of prior BPOP efforts met expectations.

- Reviewer: G-62-I
- Rating: 4

Although guarantees of success in research is difficult, especially in regard to real research, this program is building on already well documented successful baseline research into optimizing Bakken production. It is important to understand that within the area of groundbreaking research, even results that may appear to be failures, on their face, still provide valuable information for further refinement and optimization. The two-year program schedule seems reasonable for the proposed projects.

- Reviewer: G-62-I2
- Rating: 4

This project has enough longevity that it should have no problems keeping the studies moving. Nothing in the BPOP 5.0 proposal appears to be a completely new concept, therefore there should be no issues in carrying the project through the next phase after building on previous work.

- Reviewer: G-62-I3
- Rating: 5

3. The quality of the methodology displayed in the proposal is:

The methodology outlined in the proposal appears appropriate for the scope of work, and no significant omissions were identified. If selected, it will be particularly valuable to observe how advances in data science and machine learning are integrated to further support the goals of the OGRC.

- Reviewer: G-62-I
- Rating: 4

The technologies, laboratories, and personnel utilized by the EERC are among the best in the nation's oil and gas industry, perhaps even globally. The organization of the project is in alignment with previous stages of the BPOP series, and the continued inclusion of several active and significant Bakken oil and gas operators, provides access to ground level activities often unavailable to many academic equivalents.

- Reviewer: G-62-I2

- Rating: 5

The approaches detailed in the presentation are industry standard and most companies approach these challenges with similar tools and methods.

- Reviewer: G-62-I3

- Rating: 3

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Oil and Gas Research Council goals will likely be:

It is well documented that current production strategies deployed in the Bakken oilfields leave a significant portion (80+%) of the oil resource in the reservoir. The potential upside for North Dakota's petroleum industry in identifying even modest improvements in recovery techniques is substantial, with the ability to generate remarkable results for all stakeholders across the state.

- Reviewer: G-62-I

- Rating: 5

The EOR research is extremely important in the further development of the world class Bakken reservoir. The upside potential for increased proven reserves that may be developed by application of data produced by the proposed research projects, by itself, is a tremendous technological asset, when just a few percent increase in economic recovery is likely measured on the scale of billions of barrels of crude oil, plus associated natural gas and NGLs.

- Reviewer: G-62-I2

- Rating: 5

This proposal is for basin-wide solutions to formidable problems in the current O&G industry. The Bakken is a very mature play and understanding how best to proceed with next level recovery in these types of plays is very important for future US O&G activity. Of significant note is the EOR component of this proposal to which these mature plays, with very limited new-drill inventory, must rely on to enhance recovery of a known reservoir.

- Reviewer: G-62-I3

- Rating: 3

5. The background of the principal investigator and the awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is:

The team outlined in the application is exceptionally well qualified to perform the proposed work. It could be easily argued that no personnel or facilities in the world are more capable of executing the scope of work described in this proposal.

- Reviewer: G-62-I

- Rating: 5

The principal investigator, James A. Sorenson, and his associates have extensive experience in the area of Bakken production, geology, reservoir engineering, enhanced recovery research, etc. Together, the group has already submitted several BPOP reports to the NDIC/OGRC as well as published trade journal articles and technical papers in those areas. Additionally, they have also developed gas capture technology, Polar Bear, that will be field tested during this BPOP 5.0 phase.

- Reviewer: G-62-I2

- Rating: 5

Clearly access to UND staff and students gives this project an extraordinary amount of academic support and allows for a large amount of material to be composed related to the project. There is a strong track record of generated material detailed in the "Greatest Hits" portion of the presentation and the team working through BPOP 5.0 will obviously have access to all of that literature moving forward.

- Reviewer: G-62-I3

- Rating: 5

6. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is:

The schedule and financial plan appear appropriate for the proposed work. While there are no immediate concerns, the OGRC and staff should remain attentive to whether any issues have previously arisen regarding communication, timelines, or budgets.

- Reviewer: G-62-I

- Rating: 3

The EERC has a proven record of providing timely, thorough, and well documented reports to the NDIC/OGRC as part of the previous BPOP phases, and this proposed plan is modelled after those very successful projects timetables. The program schedule provides three biannual reports and a final report be submitted over the two-year plan. The requested cost share of six million dollars from the NDIC/OGRC is in line with the 50% minimum matching funds from the DOE, industry partners, and in-kind contributions, with expectations that additional industry partner funds will increase that share.

- Reviewer: G-62-I2

- Rating: 5

Page 13 and 14 of the project proposal lays out the deliverables and budget in a clear fashion.

- Reviewer: G-62-I3

- Rating: 3

7. The proposed purchase of equipment and the facilities available is:

No major equipment purchases were identified in the application. The EERC's facilities are world-class and should be more than adequate to support the proposed work. Typical expenditures, such as software, printing, and related items appear reasonable given the project scope.

- Reviewer: G-62-I

- Rating: 4

The majority of purchases appear to be related to software fees and other technical resource access charges, all reasonable considering the scope of the proposed project.

- Reviewer: G-62-I2

- Rating: 3

This project is heavily weighted to technical labor (~50%), however line item for "Facilities and Administration" representing ~33% of total project is not clearly defined in page 13 of the proposal. Clarity on what this bucket represents would be of interest.

- Reviewer: G-62-I3

- Rating: 2

8. The proposed budget "value"¹ relative to the outlined work and the commitment from other sources is of:

Based on past performance, the value of continuing the BPOP program appears extremely high. The EERC, in collaboration with its industry partners, should be well positioned to deliver strong results that provide meaningful benefits to the State of North Dakota and its many stakeholders.

- Reviewer: G-62-I

- Rating: 5

This commitment of outside funds from industry partners and the DOE, and their relative value is documented and consistent with past phases of the BPOP research. Field application testing is the bedrock of any useful research, and essential to validating laboratory and academic experiments. The BPOP has a history of solid field experimentation and testing.

- Reviewer: G-62-I2

- Rating: 3

This is a mature project that is clearly supported by significant operators in the region, therefore they see value in continuing on with BPOP 5.0 above and beyond what has already been established.

- Reviewer: G-62-I3

- Rating: 3

9. The “financial commitment”² from other sources in terms of “match funding” have been identified:

The application’s matching funds appear to meet OGRC requirements. Beyond the direct financial match in the question, the involvement of BPOP partner companies and their active collaboration on the outlined topics adds immeasurable value to the overall proposal.

- Reviewer: G-62-I

- Rating: 3

The documented sources of match funding from the DOE, industry partners, and in-kind research work and resources are well documented, and is in alignment with the minimum 50% match, plus expectations of additional industry partner matching funds expected as the project proceeds.

- Reviewer: G-62-I2

- Rating: 3

The partner list for BPOP 4.0 represents the biggest operators in the basin, however the commitment of \$1.2M on a \$12M project from said operators is interesting. Are they concerned that the value add from continued research has reached it peak?

- Reviewer: G-62-I3

- Rating: 2

1 “value” – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar. A commitment of support from industry partners equates to a higher value.

2 “financial commitment” from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Support less than 50% from Industrial Commission sources should be evaluated as favorable to the application; industry partnerships equates to increased favorability.

General Comments

Continuation of BPOP funding at the requested level is strongly recommended. BPOP 5.0’s proposed outcomes align exceptionally well with the documented goals and objectives of the OGRC. Few OGRC programs have delivered as much long-term value to the state of North Dakota as the BPOP program, which has provided 11 years of impactful results. Based on the program’s

past successes, there is high confidence that the next round will generate another round of insights capable of again advancing Bakken development to the next level. In the near term, the greatest value will likely come from the expansion of economically viable drilling opportunities in the fringe (Tier 3) areas of the state, followed closely by the development of implementation strategies for improved oil recovery (IOR) and enhanced oil recovery (EOR).

- Reviewer: G-62-I

Additional research goals of hydrogen sulfide source determination are needed, and research of the past history of Bakken production will show that this is not from the Bakken formation or Three Forks formations, and was never found in those reservoirs, until the advent of high injection rate and high slurry volume treatments. This points to out of zone vertical fracture growth, into the overlying sour intervals of the Madison, as the likely culprit. The extremely high salinity and elevated temperature of the produced water in the Bakken, particularly in the center of the Williston basin, is very inhibitive to reservoir bacteria growth. The solution is not likely to be found in fracturing fluid chemistry or biocides, but in actually paying attention of the plethora of micro-seismic data, fracture modeling with realistic geologic stress modeling that consistently show extreme vertical fracture growth. Tracer and temperature logs, run in the past on vertical Bakken completions, regularly showed vertical upward growth of at least 250' to 300', even in small 60,000 gal gelled oil treatments, pumped at 12 to 15 bpm. Another area that will likely rear its head once EOR injection begins, is the loss of hydraulic fracture proppant conductivity and fracture to wellbore connectivity due to high temperature degradation of the silica-based proppants, and the deposition of free salt in the proppant pack and fracture. A significant portion of the benefits of post injection treatments, with surfactants in freshwater or low salinity brines, is likely due to dissolution of salt deposits in the fracture, rather than solely wettability and capillary effects, particularly in the critical near-wellbore area where fracture geometry results in a convergent flow choking effect.

- Reviewer: G-62-I2

This proposal is the 5th iteration of a project that has been ongoing for over 12 years. The key points of research are definitely relevant to the current state of O&G in ND, and the nation overall, and are important to understanding how best to unlock future potential from mature plays. I do question why there needs to be a 5th iteration of the BPOP, as many of the focus areas are relatively standard analysis for operators in O&G basins, especially the large operators listed as partners. Therefore, I see this proposal as much more cultural than technical, meaning the key operators in ND are interested in partnering with current and future academia in hopes of securing relationships and networks within the State. There is no doubt that the literature produced by previous BPOP iterations have been useful to operators in the basin but the BPOP 5.0 proposal appears to be very vague in what it hopes to deliver, especially given that the 4.0 partners likely have invested significant effort into solving these problems internally for their localized plays. That said, this appears to be a longstanding partnership with the EERC, and UND, and I see no issues continuing the study as they are relevant challenges, however I would encourage the EERC to limit their focus to one or two key issues rather than tackling. Of note, DJ Basin operators partnered with Colorado School of Mines in a similar fashion and the project was very successful and was a cultural win for the State. I think these partnerships are important to link academia and industry together, but it is also important to keep an eye on your scope, lest you end up spending money recklessly.

- Reviewer: G-62-I3