



INDUSTRIAL COMMISSION OF NORTH DAKOTA

Kelly Armstrong
Governor

Drew H. Wrigley
Attorney General

Doug Goehring
Agriculture Commissioner

Monday, October 27, 2025

BND Executive Conference Room or Microsoft Teams – 1:30 pm

Join on your computer or mobile app

[Join the meeting now](#)

Or call in (audio only)

[+1 701-328-0950,,844506188#](#)

I. Roll Call and Pledge of Allegiance

(approximately 1:30 pm)

II. Bank of North Dakota and BND Advisory Board – Don Morgan, Advisory Board Members Karl Bollingberg, Dennis Johnson, Brenda Foster, Kathleen Neset, Christie Obenauer, Bill Price, Jean Voorhees

- A. CEO Report (Attachment 1)
 - i. Executive Summary
 - ii. Vision/Traction Organizer
 - iii. Strategic
 - iv. Financials
 - v. Risk
 - vi. Policy and Program Approvals
- B. Ag Disaster 2025/2026 Discussion
- C. Furloughed Federal Employee Relief Program Update
- D. Presentation of Non-confidential August 20, 21, 2025 Advisory Board and Committee Meeting Minutes (Attachment 2)
- E. Other BND and Advisory Board Business

**Meeting Closed to the Public for Executive Session Pursuant to NDCC
6-09-35, 44-04-18.4, 44-04-19.2 and 54-17.5-06**

(approximately 2:30 pm)

III. Bank of North Dakota and BND Advisory Board Confidential Business

- A. Roughrider Coin Discussion
- B. Presentation of Confidential Aug 20, 21, 2025 Advisory Board and Committee Meeting Minutes (Confidential Attachment 3)
- C. Other BND and Advisory Board Confidential Business

IV. Lignite Research Program Applicant Confidentiality Request – Jordan Kannianen, Ed Murphy

Meeting Returns to Public Session

(approximately 3:00 pm)

V. Action on Executive Session Items

VI. North Dakota Public Finance Authority – DeAnn Ament

- A. **Consideration of Approval of the Following State Revolving Fund Loan:**
 - i. City of Mandan – Drinking Water - \$4,491,000 (Attachment 4A-F)
- B. **Consideration of Approval of Resolution Providing for Reimbursement of Certain Costs of State Revolving Fund Programs** (Attachment 4G)
- C. Presentation of Report on the Sale of \$43,610,000 Capital Finance Program Bonds, Series 2025A (Attachment 5)
- D. Other NDPFA Business

(approximately 3:15 pm)

VII. Department of Mineral Resources – Nathan Anderson, Mark Bohrer

- A. **Order 34057 in Case 31357** – Regarding Application of Spotted Hawk Development, LLC to amend field rules for Van Hook and/or Deep Water Creek Bay-Bakken Pool for 4160 acre spacing unit and authorize up to eight wells, dissolving other spacing units as necessary, and such further relief as appropriate (Attachment 6)
- B. **Order 34622 in Case 31880** – Regarding application of Devon Energy Williston, LLC to amend field rules for Glass Bluff-Bakken Pool, Foremen Butte-Bakken Pool and/or Nameless-Bakken Pool for overlapping 3200 acre spacing unit, authorizing not more than ten wells and other relief as appropriate (Attachment 7)

- C. **Order 34198 in Case 31477** – Regarding application of CTI Well Service to transfer certain confiscated wells as identified in Rough Rider and Grassy Butte Fields to CTI Well Service as Operator to bring back on production and other relief as appropriate (Attachment 8)
- D. **Order 34355 in Case 31623** – Regarding Petition of Cobra Oil & Gas Corp for unitized management, operation, and development of Bull Moose-Duperow Unit Area, approval of plan of operation, vacating applicable spacing orders and other relief as appropriate (Attachment 9)
- E. **Order 34356 in Case 31624** – Regarding application of Cobra Oil & Gas Corp for determination that unitization for Bull Moose-Duperow Unit Area is signed, ratified or approved by owners of interest as required by statute and rules of Commission (Attachment 10)
- F. **Order 34728 in Case 31976** – North Dakota Industrial Commission, Complainant, v. Rocky Top Energy, LLC Administrative Complaint, Imposition of Civil Penalties (Attachment 11)
- G. Other DMR Business

(approximately 4:00 pm)

VIII. Oil and Gas Research Program – Brent Brannan, Jordan Kannianen

- A. Presentation of OGRP Project Management and Financial Report (Attachment 12)
- B. **Consideration of Approval of Grant Round 62 Applications Approved by Oil and Gas Research Council**
 - i. G-062-L: "Large-Scale Hydrocarbon Gas Injection EOR Pilot to Inform Future CO2 EOR in the Bakken" Chord Energy; Total Project Cost: \$38,632,967; Request: \$13,998,200 (Attachment 13)
 - ii. G-062-I: "Bakken Production Optimization Program (BPOP) 5.0" EERC; Total Project Cost: \$12,030,206; Request: \$6,000,000 (Attachment 14)
 - iii. G-062-O: "Proposal for Subfactant-Based EOR Pilot Testing Program, Bakken – Three Forks Formations, Williston Basin, ND" Devon; Total Project Cost: \$3,370,000; Request: \$1,535,000 (Attachment 15)
 - iv. G-062-H: "Enhanced Oil Recovery and Advanced Completion Design for Tight Carbonate Reservoirs in Western North Dakota" Cobra Oil & Gas Corp; Total Project Cost: \$10,000,000; Request: \$5,000,000 (Attachment 16)
 - v. G-062-M: "Williston Basin Resources Optimization: Large-Scale Miscible Gas Huff n Puff EOR Pilot in Continental's Dunn County

- Acreage – Roadrunner/Clover Pad” Continental Resources; Total Project Cost: \$26,889,228; Request: \$8,771,905 (Attachment 17)
- vi. G-062-N: “A Multi-Well, Multi-Zone Enhanced Oil Recovery Project Utilizing Produced Natural Gas in Williams County – Durant Pad” Continental Resources; Total Project Cost: \$29,918,810; Request: \$9,836,905 (Attachment 18)

C. Other OGRP Business

(approximately 4:30 pm)

IX. Renewable Energy Program – Jordan Kannianen

- A. Presentation of REP Project Management and Financial Report (Attachment 19)
- B. **Consideration of Approval of Grant Round 56 Applications Approved by Renewable Energy Council**
 - i. R-056-A: “Unlocking Lithium Carbonate in Produced Water for Battery Grade Li₂CO₃ for in-State Cathode Manufacturing” Triple 8 LLC dba Wellspring Hydro; Project Cost \$1,000,000; Request: \$500,000 (Attachment 20)
 - ii. R-056-B: “Empowering the Critical Minerals for Novel Cathode Materials-based Drone Batteries” University of North Dakota; Project Cost \$1,000,000; Request: \$500,000 (Attachment 21)
- C. Other REP Business

(approximately 4:45 pm)

X. Industrial Commission Administrative Office

- A. **Consideration of Approval of July 30, 2025, Industrial Commission Meeting Minutes** (Attachment 22)
- B. **Consideration of Approval of Mill President Bonus** (Attachment 23)
- C. Other Administrative Office Business

XI. Adjournment

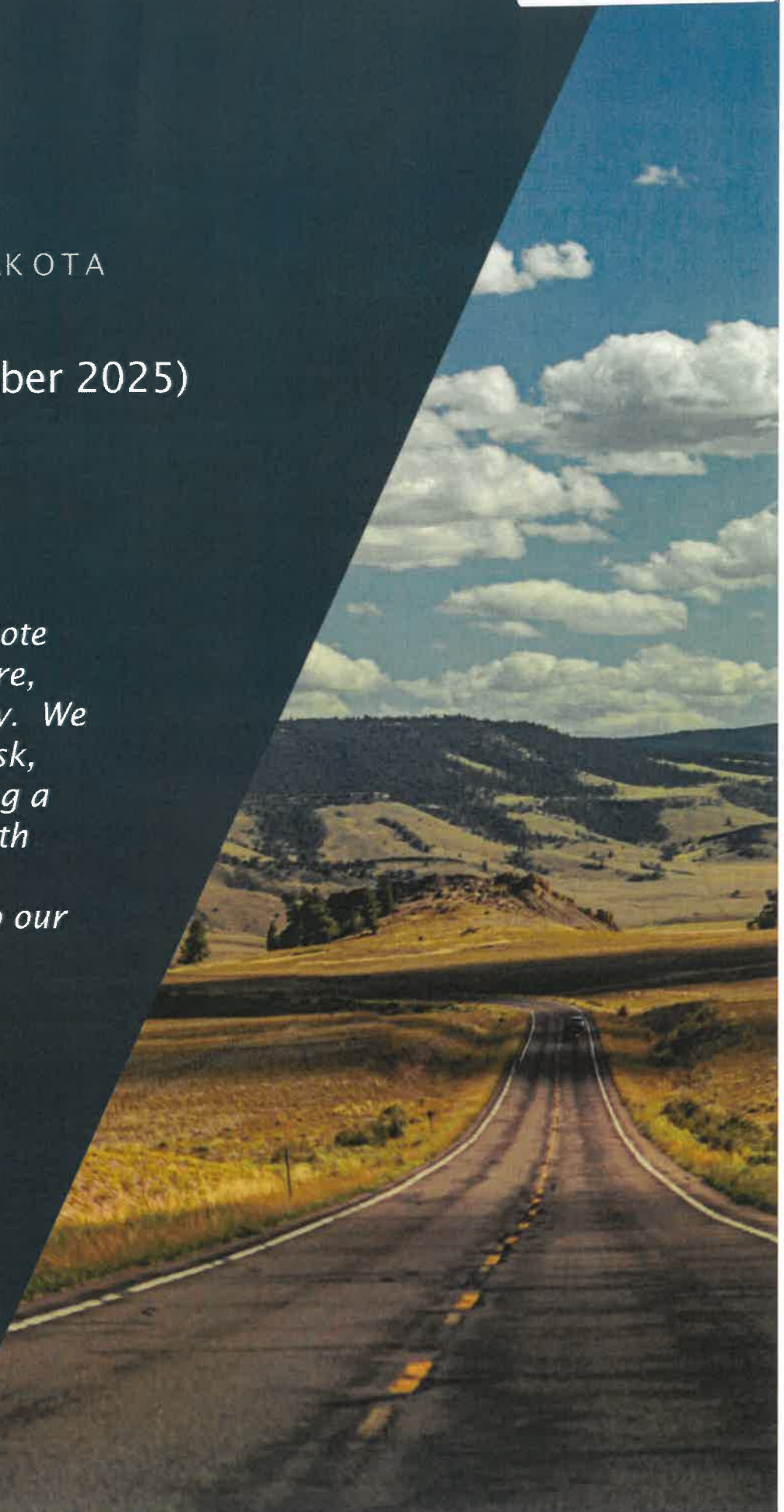
Next Regular Industrial Commission Meeting – Tuesday, November 25, 2025
9:00 am – 12:30 pm
Governor’s Conference Room



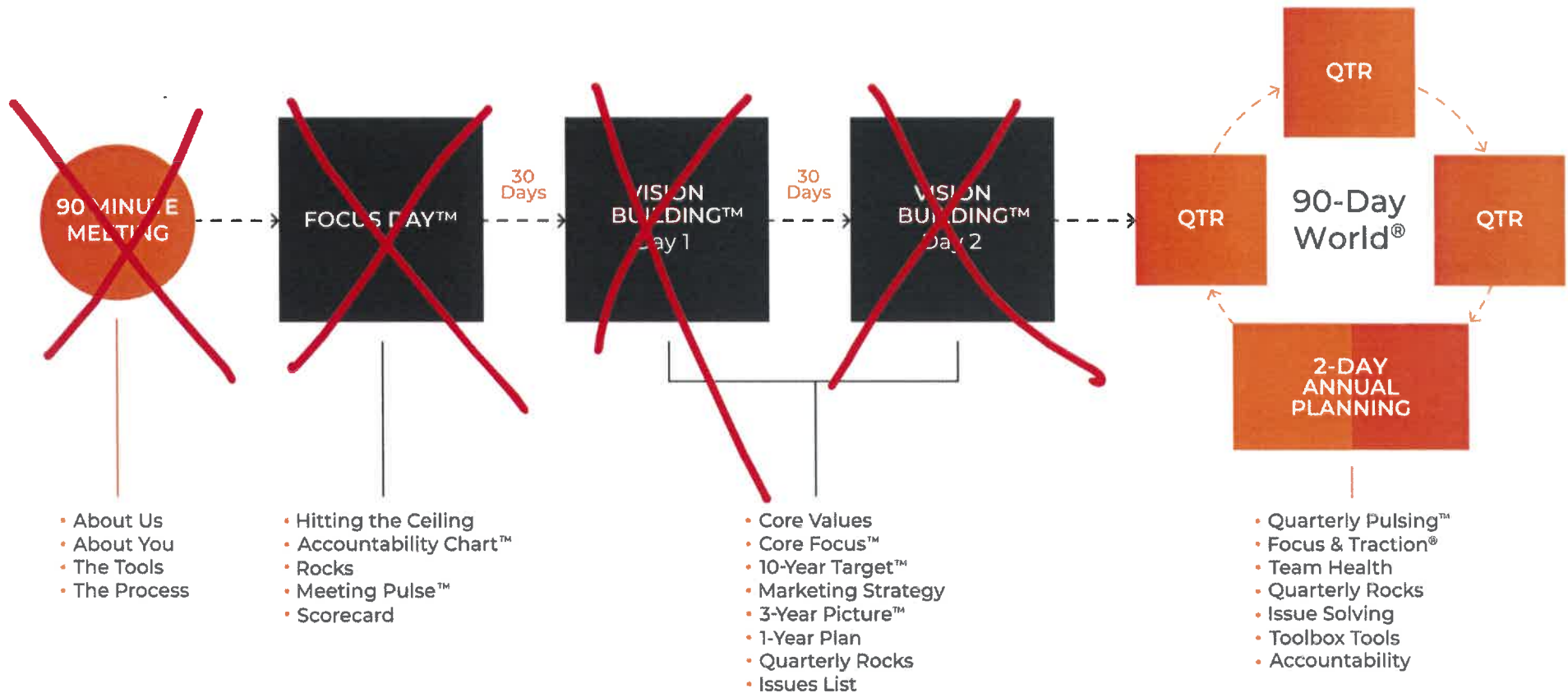
BANK OF NORTH DAKOTA

CEO Update - (October 2025) (Non-Confidential)

"Our mission is to promote North Dakota agriculture, commerce, and industry. We do that by managing risk, providing liquidity, being a growth catalyst for North Dakota, and earning a balanced total return to our State."



Strategic (Traction EOS)



Strategic (Vision/Traction Organizer (the "VTO"))

BND Vision/Traction Organizer ("VTO")		
Core Values	<i>we are North Dakota Proud with a Passionate Mission Focus engaging in Creative Solutions Leadership and There When Needed with Integrity and Purpose</i>	4-Year Picture (December 31, 2029)
Core Focus	Mission: "Promote ND Agriculture, Commerce, & Industry" Niche: North Dakota's Bank 1) Risk managers 2) Liquidity providers 3) Growth catalysts 4) Total Return back to our State	Financials: Assets: \$11 billion (<i>instead of \$9 billion</i>) Total Return (\$): \$450 million (<i>instead of \$355 million</i>) Total Return %: 5.43% (<i>instead of 4.82%</i>) FinTech Funding: \$750 million (<i>instead of none</i>) Loans: \$7 billion (<i>instead of \$5.6 billion</i>) Loan-to-Deposit Ratio: 78% (<i>instead of 75%</i>)
Core Target (2035)	\$14 billion Assets \$3 billion "FinTech Funding" to grow and invest back into ND Stable and increasing "Total Returns" Robust and evolved "Mission" fulfillment More relevant than ever Meeting North Dakota's needs as "North Dakota's Bank"	What Does It Look Like? 1) "Strong Banking" - Strong risk mitigation in all respects (credit, ERM, compliance, strategic...) 2) "Strong Relationships" - Enhanced shareholder relationships within governance model... - BND operated as "Bank owned by State" not as "State agency"... - Operational and relational enhancements with State agencies... - FI partnerships are stronger than ever... - Experts helping our FI partners "Figure Out FinTech"... - "Telling Our Story" uniquely and creatively... 3) "BND Talent Management Culture" - Attracting, retaining, developing, career pathing, working hard yet having fun... - Balanced "AI" integration into all business channels... 4) "FinTech Funding" - "Roughrider Coin" up, running, and bringing value to ND FI's... - "Roughrider Bank" (digital) up, running, and growing... - Custodial services in place and scaling... - Program management / embedded banking up, running, and growing... - Earned Wage Access ("EWA") up, running, and providing value to the State... - Expanded correspondent services from ND to surrounding region (SD, WY, ID, MT, NE)... 5) "Mission, Mission, Mission" - Relevant and fulfilling on our "Mission"... - Holistically helping ND kids all the way through college... - Legislative programs robust, growing, and evolving... - Sustainable and ethical banking (doing the right thing)...
Marketing	Target Market(s): Financial Institutions - North Dakota banks and credit unions who desire our continued partnership State Agencies - North Dakota agencies who desire to evolve State Stakeholders - North Dakota key players Digital Bank (Take ND to the Nation) - Out of North Dakota who love the concept of North Dakota greatness and the idea of a State-sovereign Bank Embedded Banking (The Right Partners) - Out of North Dakota operationally vanilla programs with great optics and moderate risk profiles Three Uniques: 1. Mission Driven - North Dakota first 2. Stable Legacy - 106 years ('nuff said) 3. First Responders - There for North Dakota when needed Proven Process: Identify issue & impact Ideate solutions Initiate strength of the State	

BND Vision/Traction Organizer ("VTO")	
Annual Goals (December 31, 2026)	Company Quarterly Rocks (Q4 2025)
Financials: Assets: \$9.8 billion Total Return (\$): \$369 million Total Return %: 5.31% FinTech Funding: None (in building phase) Loans: \$6.3 billion Loan-to-Deposit Ratio: 77% Annual Goals <i>(To be built for 2026 in December 2025)</i>	Company Rocks 1) "Roughrider Coin" business use case and beta framework developed. <i>(Helping ND FI's and FinTech Funding)</i> 2) "Commercial Center" go live achieved. <i>(Enhanced FI operations and relations)</i> 3) 2026 Farm Financial Stability Program approved and communicated. <i>(There when needed)</i> 4) Written transition plans for Communications, Student Loans, Ops and Innovation departments (Accountability Chart). <i>(BND Talent Management Culture)</i> 5) Rollout of Traction EOS "Rocks" concept to Executive lieutenants. <i>(Traction EOS rollout and BND Talent Management Culture)</i> 6) 2026 Budget finalized and approved. <i>(Financial results and accountability)</i>



New Initiatives

No new updates for the month.

Governance

No new updates for the month.

Financials

Balance Sheet

Income Statement

No new updates for the month.

Risk

Enterprise Risk Management ("ERM")

Credit Quality

Liquidity

No new updates for the month.



2025 Storm Disaster Program



Loan Applications Pending

11

Number of Loans Funded

83

Amount Paid Down/Paid Off

\$223,155.27

Total Funds

\$37,000,000.00

Total Amount Pending

\$1,660,457.44

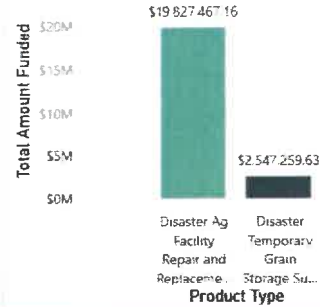
Total Amount Funded

\$22,374,726.79

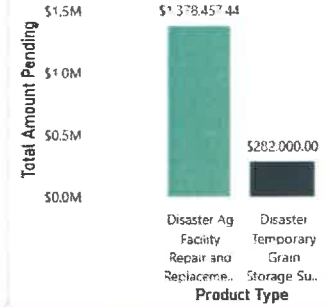
Remaining Funds Available

\$13,187,971.04

Funded Amount by Program

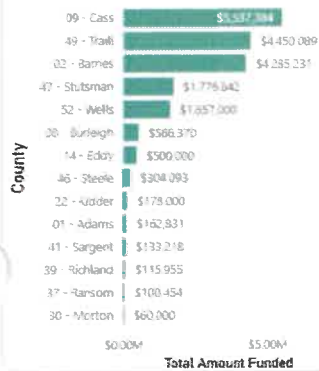


Pending Amount by Program



Disaster Ag Facility and Replacement

Total Amount Funded by County

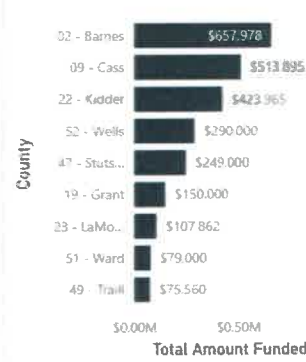


Total Amount Pending by County

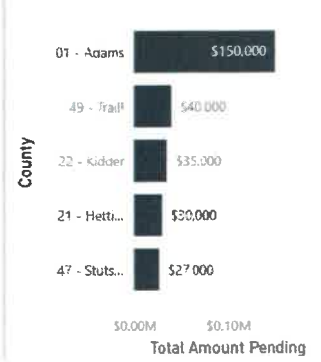


Disaster Temporary Grain Storage Support

Total Amount Funded by County



Total Amount Pending by County





1200 Memorial Hwy
PO Box 5509
Bismarck, ND 58506-5509

Telephone: 701.328.5600
Toll-Free: 800.472.2166
TTY: 800.366.6888
bnd.nd.gov

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October 13, 2025

PUBLIC FINANCE AUTHORITY ADVISORY COMMITTEE

RECOMMENDATION TO THE INDUSTRIAL COMMISSION

The Advisory Committee, at its October 13, 2025 meeting, reviewed, discussed, and recommends approval of a \$4,491,000 Drinking Water State Revolving Fund Program loan to the City of Mandan.

North Dakota Public Finance Authority
Advisory Committee

Keith Lund, Chairman
Linda Svihovec
John Phillips

Industrial Commission
of North Dakota

Kelly Armstrong
GOVERNOR

Drew H. Wrigley
ATTORNEY GENERAL

Doug Goehring
AGRICULTURE COMMISSIONER



Public Finance Authority

Memorandum

To: Public Finance Authority Advisory Committee
Miles Silbert, Public Finance Management
Kylee Merkel, Bank of North Dakota

From: DeAnn Ament, Executive Director

Date: October 8, 2025

Re: City of Mandan
Drinking Water State Revolving Fund Program Loan Application

Purpose of the Project: Begin the process of replacing some of the 58 known lead service lines out of approximately 4,481 unknowns.

Project Amount:

DWSRF Request	\$ 4,491,000
Loan Forgiveness	(2,964,060)
Net Loan	\$ 1,526,940

Population to Benefit from the Project: 653

Population Served by the System: 24,872 plus Missouri West Water System which serves 8,100 people

The requested term for the DWSRF loan is 20 years. The City will issue revenue bonds payable with water and sewer user fees. Accordingly, the net average annual payment loan will be approximately \$75,922. The required debt service reserve is \$80,000 and the 110% net operating coverage requirement is \$83,514.

The City currently has 8,615 residential connections that pay a water/wastewater base rate of \$36.80 and 796 commercial connections that pay a water/wastewater base rate of \$73.60, and both pay \$3.00/100 cubic foot of water usage and \$1.65/100 cubic foot of wastewater disposal. Effective January 1, 2025, these rates reflect the monthly base rate increase for residential users of \$4.75 and for commercial users \$9.50 which will result in annual revenue of approximately \$581,799.

Water & Wastewater Fund:

	2021	2022	2023	2024
Operating Revenue	\$12,373,258	\$11,710,926	\$10,216,792	\$9,648,947
Operating Expenses	6,253,921	6,315,164	6,648,226	7,584,183
Net Operating Revenue	6,119,337	5,395,762	3,568,566	2,064,764
Depreciation	2,579,500	2,530,360	2,801,245	3,416,587
Adjusted Net Operating Revenue	\$8,698,837	\$7,926,122	\$6,369,811	\$5,481,351
Revenue Bond Payments	\$2,704,720	\$2,724,636	\$2,710,801	\$2,760,201
Net Operating Coverage	322%	291%	235%	199%
Proforma Rate Increase Revenue	\$581,799	\$581,799	\$581,799	\$581,799
Proforma DWSRF Payment	\$666,715	\$666,715	\$666,715	\$666,715
Proforma Net Operating Coverage	275%	251%	206%	177%

Existing net revenues coupled with the implemented water/wastewater base rate increases should allow the City to continue meeting the coverage requirements.

Outstanding Debt as of December 31, 2024:

	Original Debt	Outstanding Debt
General Obligation Bonds - Bridge	\$ 870,000	\$ 130,000
Improvement Bonds	61,951,888	48,615,567
Sales Tax Revenue Bonds - Sports Complex	15,275,000	9,065,000
Revenue Bonds - Water & Sewer ¹	38,436,239	20,322,905
Total	\$ 116,533,127	\$ 78,133,472

¹ Payments to the NDPFA have been made as agreed. The City has eight DWSRF loans with a total outstanding balance of \$14,847,605 and five Clean Water SRF (CWSRF) loans that total \$5,305,000. In 2025, four DWSRF loans and one CWSRF loan totaling \$34,330,000 have closed and started drawing. The City had debt service reserves of \$3,615,036.

The average annual payment of all outstanding debt including this new request is \$11,104,885 which is \$459 per resident.

The City of Mandan is located in Morton County on Interstate 94. Based on the 2020 census, the total population is 24,206; this is an increase of 5,875 over the 2010 census. The largest employers in the City are Mandan Public Schools with 697 employees, HIT, Inc. (social assistance) employs 641 and NISC (information services) with 460 employees.

K-12 School Enrollment:

				Projected
2022-2023	2023-2024	2024-2025	2025-2026	2026-2027
4,223	4,277	4,368	4,395	4,400

The City's 2024 taxable valuation was \$131,480,934. This is an increase of \$32,318,077 over the 2020 taxable valuation.

Property Tax Levies and Collections as of 9/11/2025:

Levy Year	Dollar Amount of Levy	Amount Collected to Date of Application	Percentage Collected
2024	\$8,508,223	\$8,177,416	96%
2023	\$8,019,297	\$7,968,335	99%
2022	\$7,300,894	\$7,291,569	100%

Special Assessment Levies and Collections 9/11/2025:

Year	Dollar Amount	Amount Collected to Date of Application	Percentage Collected
2024	\$6,737,373	\$6,038,520	90%
2023	\$4,541,789	\$4,450,619	98%
2022	\$4,602,813	\$4,589,950	100%

City of Mandan Mill Levy:

Year	City	School	Park District	State and County	Other	Total for Each Year
2024	64.09	128.14	29.15	55.09	4.00	280.47
2023	63.93	127.22	29.13	56.74	4.00	281.02
2022	63.85	130.15	29.15	60.23	4.00	287.38
2021	63.98	130.15	28.29	58.74	4.00	285.16
2020	63.21	108.15	28.84	57.71	4.00	261.91



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Memorandum

TO: DeAnn Ament, Executive Director
North Dakota Public Finance Authority

FROM: PFM Financial Advisors LLC

DATE: October 15, 2025

RE: Marketplace Analysis - Drinking Water State Revolving Fund Program
City of Mandan

The City of Mandan (“City”) has presented a request to the Authority and the North Dakota Department of Environmental Quality (“Department”) for a \$4,491,000 loan of which \$2,964,060 will be loan forgiveness, for a total of \$1,526,940 under the Drinking Water State Revolving Fund Program (“DWSRF Program”). The DWSRF Program is used to make subsidized interest rate loans to political subdivisions for the purpose of constructing various water treatment, distribution, and storage facilities as approved by the Department in accordance with federal and state regulations and an updated Intended Use Plan prepared by the Department.

The City intends to use the proceeds to begin the process of replacing some of the 58 known lead service lines out of approximately 4,481 unknowns.

The municipal securities to be acquired by the Authority will be revenue bonds payable from water and sewer user fees. The City’s average annual payment under the proposed loan will be approximately \$75,922 indicating a 110% net revenue coverage requirement of approximately \$83,514. The City will be required to deposit \$80,000 into a reserve fund with payments of \$16,000 per year for the first five years of the loan. Starting in 2025, the City increased their water/wastewater monthly base rates for residential users by \$4.75 and for commercial users by \$9.50, which will generate annual revenue of approximately \$581,799. Pro forma net operating coverage of the Water & Wastewater Fund was 2.75x, 2.51x, 2.06x and 1.77x for 2021-2024, respectively. The existing net operating revenue in addition to the approved rate increases will provide sufficient net revenues to meet the 110% coverage requirement.

As of December 31, 2024, the City has \$48,615,567 of Improvement Bonds, \$9,065,000 of Sales Tax Revenue Bonds, \$20,322,905 of Revenue Bonds, and \$130,000 of General Obligation Bonds outstanding. The City has five Clean Water SRF loans with \$5,305,000 outstanding and eight Drinking Water SRF loans with \$14,847,605 outstanding with an additional \$34,330,000 of loans that have closed in 2025, which includes one Clean Water and four Drinking Water SRF loans. The City is current in its payments for its outstanding Authority loan.

Funding for the construction of the City's projects has been included in a list of approved projects as prepared and updated by the Department. As an authorized participant in the DWSRF Program, the City will benefit substantially from the subsidized fixed rate loans made under the Program. Consequently, no other financing mechanism can provide a greater cost advantage than that offered by the DWSRF Program.

Attachment 4E

Memorandum

To: Industrial Commission

From: Kylee Merkel, Business Banker
Bank of North Dakota

Date: October 9, 2025

RE: City of Mandan
Drinking Water State Revolving Fund Program

ND Public Finance Authority has delivered to BND their memo which recommends approval of a \$4,491,000 loan to the City of Mandan under the Drinking Water State Revolving Fund (DWSRF). This project is eligible for \$2,964,060 of DWSRF loan forgiveness, making the net loan amount \$1,526,940. DWSRF is financing the entire cost of the project.

The project will replace 58 of the known lead service lines throughout the City. The requested loan term is 20 years. The City will issue a revenue bond payable with water and sewer user fees. The annual payment will average \$75,922.

Water & Wastewater Fund:

Water and Wastewater Fund	2022	2023	2024	Projected
Operating Revenue	11,710,926	10,216,792	9,648,947	9,648,947
Projected Rate Increase				581,799
Operating Expenses	-6,315,164	-6,648,226	-7,584,183	-7,584,183
Net Operating Revenue	5,395,762	3,568,566	2,064,764	2,646,563
Plus: Depreciation	2,530,360	2,801,245	3,416,587	3,416,587
Adjusted Net Operating Income	7,926,122	6,369,811	5,481,351	6,063,150
Current Debt Service	2,724,636	2,710,801	2,760,201	3,344,481
Proposed Debt Service				75,922
Total Debt Service				3,426,916
Debt Service Coverage	291%	235%	199%	177%

The City currently serves 8,615 residential connections that pay a monthly water/wastewater base rate of \$36.80 and 796 commercial connections that pay a monthly water/wastewater base rate of \$73.60. All connections pay a volume charge of \$3.00 per 100 cubic feet of water usage and \$1.65 per 100 cubic feet of wastewater disposal. The City increased the monthly base rate by \$4.75 for residential connections and \$9.50 for commercial connections. This will generate an approximate \$581,799 increase in annual revenues.

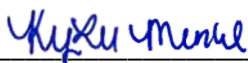
Outstanding Debt (as of December 31, 2024):

	Original Amount	Current Balance
General Obligation Bonds	870,000	130,000
Improvement Bonds	61,951,888	48,615,567
Sales Tax Revenue Bonds	15,275,000	9,065,000
Water/Sewer Revenue Bonds	38,436,239	20,322,905
	116,533,127	78,133,472

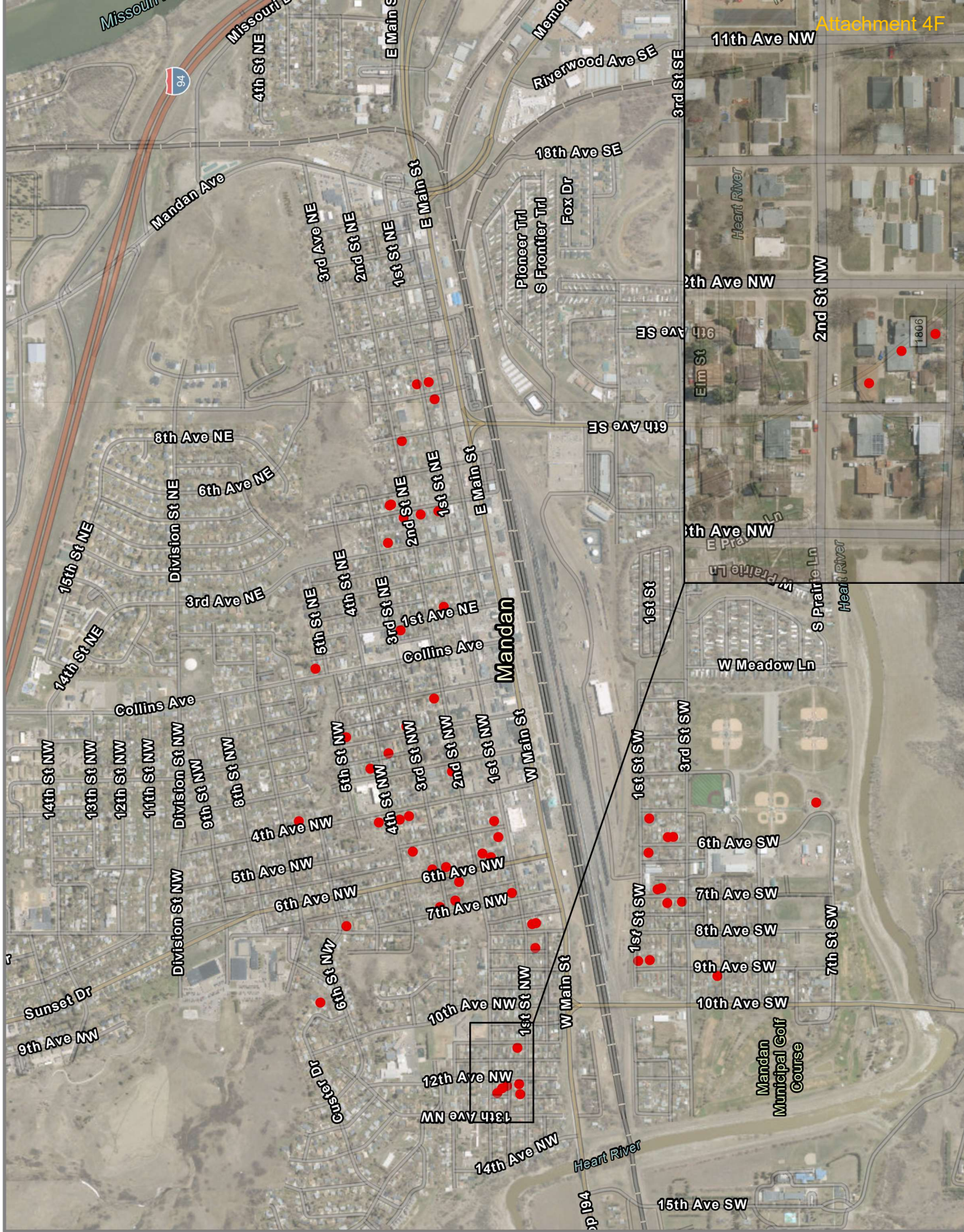
Average annual debt service requirements are estimated at \$11,104,885, which is an average of \$458.77 per resident.

Historical census populations for the City of Mandan were 24,206 in 2020, 18,331 in 2010 and 16,718 in 2000. The largest employers in the City are Mandan Public School District, Housing Industry Training (HIT) and National Information Solutions Cooperative (NISC).

Based upon the PFA recommendation and the benefits obtained with this project, BND concurs with their evaluation and support of the request.



Kylee Merkel
Business Banker



45 South Seventh Street 612.338.3535
Suite 2950 www.pfm.com
Minneapolis, MN 55402



October 15, 2025

DeAnn Ament, Executive Director
North Dakota Public Finance Authority
1200 Memorial Highway, 3rd Floor
PO Box 5509
Bismarck, ND 58506-5509

Dear Ms. Ament,

In our role as independent municipal advisor to the North Dakota Public Finance Authority (the "Authority"), PFM Financial Advisors LLC ("PFM") has carefully reviewed the structure and pricing of the Authority's \$43,610,000 Capital Financing Program Bonds, Series 2025A (the "Series 2025A Bonds"). The following is intended to serve as a summary of the bond sale.

Transaction Summaries

\$43,610,000 Capital Financing Program Bonds, Series 2025A

The Authority competitively sold the Series 2025A Bonds on October 1, 2025 to (1) refund the Authority's outstanding Capital Financing Program Bonds, Series 2015B (the "Series 2015B Bonds") and Capital Financing Program Bonds, Series 2015C (the "Series 2015C Bonds") (together, the "Refunded Bonds") and thereby refinance loans made to the Cities of Forman, Watford and Zap with the proceeds of the Refunded Bonds, and (2) provide moneys to lend to City of Burlington through the purchase of approximately \$1.4 million of municipal utility fee bonds to finance the city's lagoon expansion project. The Authority received eleven bids, as summarized below.

<u>Bidder</u>	<u>Net Interest Cost</u>	<u>True Interest Rate</u>
Fifth Third Securities*	\$16,965,907.31	3.6744%
UBS Financial Services Inc.	\$17,004,498.40	3.6849%
Wells Fargo Bank, N.A.	\$17,008,235.54	3.6859%
Piper Sandler & Co.	\$17,012,484.47	3.6871%
Huntington Securities, Inc.	\$17,023,994.93	3.6902%
Mesirow Financial, Inc.	\$17,024,310.03	3.6903%
Jefferies LLC	\$17,033,402.94	3.6928%
Keybanc Capital Markets	\$17,034,225.12	3.6930%
Robert W. Baird	\$17,058,173.15	3.6996%
Brownstone Investment Group, LLC	\$17,121,207.93	3.7168%
Morgan Stanley & Co., LLC	\$17,242,299.31	3.7499%

*Low bidder.

Spread to BVAL

The following table shows the yields for the Series 2025A Bonds and their spread to the June 1 Interpolated BVAL AAA Municipal Curves (BVAL). The Interpolated BVAL AAA curve represents the valuation of AAA rated general obligation credits, assuming a 5.00% coupon, based on market activity in both the primary and secondary municipal bond market. BVAL uses real-time market data and transaction information for a more accurate and transparent representation of the municipal market.

<u>Maturity</u>	<u>Coupon</u>	<u>Yield</u>	<u>Spread to June BVAL AAA</u>	<u>Maturity</u>	<u>Coupon</u>	<u>Yield</u>	<u>Spread to June BVAL AAA</u>
2026	5.00%	2.53%	0.25%	2036	5.00%	3.25%	0.27%
2027	5.00%	2.44%	0.19%	2037	5.00%	3.39%	0.27%
2028	5.00%	2.42%	0.19%	2038	5.00%	3.53%	0.28%
2029	5.00%	2.42%	0.19%	2039	5.00%	3.65%	0.25%
2030	5.00%	2.46%	0.20%	2040	5.00%	3.78%	0.28%
2031	5.00%	2.53%	0.18%	2041	5.00%	3.91%	0.31%
2032	5.00%	2.68%	0.22%	2042	5.00%	4.02%	0.30%
2033	5.00%	2.79%	0.24%	2043	5.00%	4.11%	0.31%
2034	5.00%	2.90%	0.22%	2044	5.00%	4.19%	0.31%
2035	5.00%	3.07%	0.23%	2045	5.00%	4.25%	0.30%

PFM reviewed the results of the Authority's Series 2025A Bonds with regard to prevailing market conditions, and it is our opinion that the interest rate scales, couponing, reoffering yields and underwriting compensation received for the Series 2025A Bonds are fair and favorable to the Authority. The final pricing for the Series 2025A Bonds resulted in a gross underwriting spread of \$135,772.94 or \$3.11 per face amount of bonds.

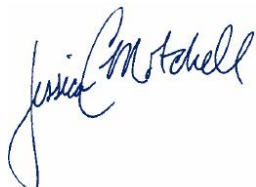
We also opine that the Authority's Series 2025A Bonds were appropriately priced relative to other issues sold or trading in the secondary market during the same period. PFM believes that the final all-in true interest cost of 3.7317% for the Series 2025A Bonds are favorable to the Authority in light of prevailing market conditions. Additionally, PFM believes that these statistics are comparable to the interest rate levels of similar transactions sold either competitively or through negotiated placement in the market during the week of sale.

S&P Global Ratings affirmed the Series 2025A Bonds a "AA-" credit rating prior to the receipt of bids.

We greatly appreciate the opportunity to have served as financial advisor to the Authority on the Series 2025A Bonds and we look forward to being of continued service on future financing transactions. As always, we will be available to respond to any questions you may have concerning the contents of this memorandum or on any part of the financing process.

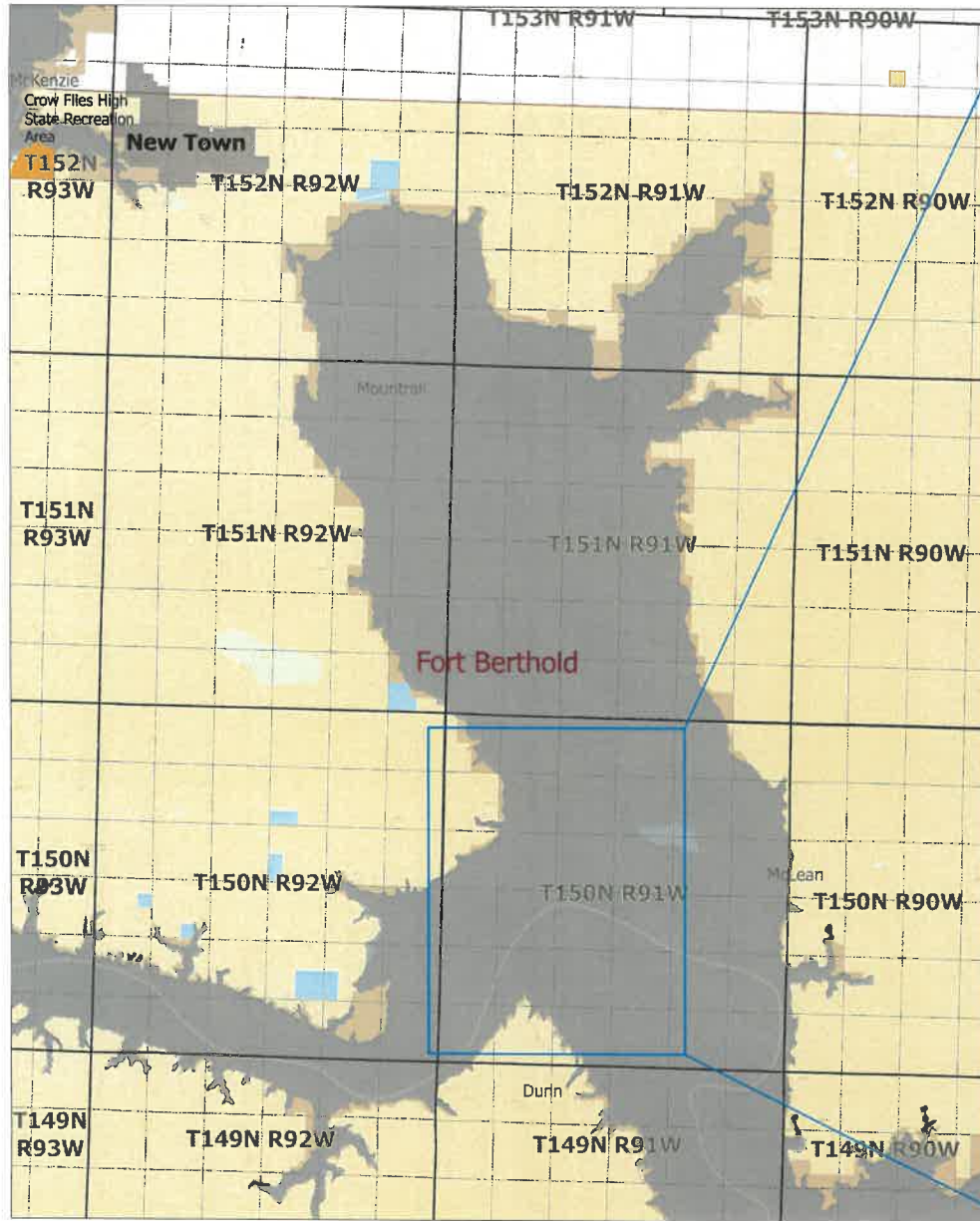
Sincerely,

PFM Financial Advisors LLC



Jessica Cameron Mitchell
Managing Director

Industrial Commission c31357

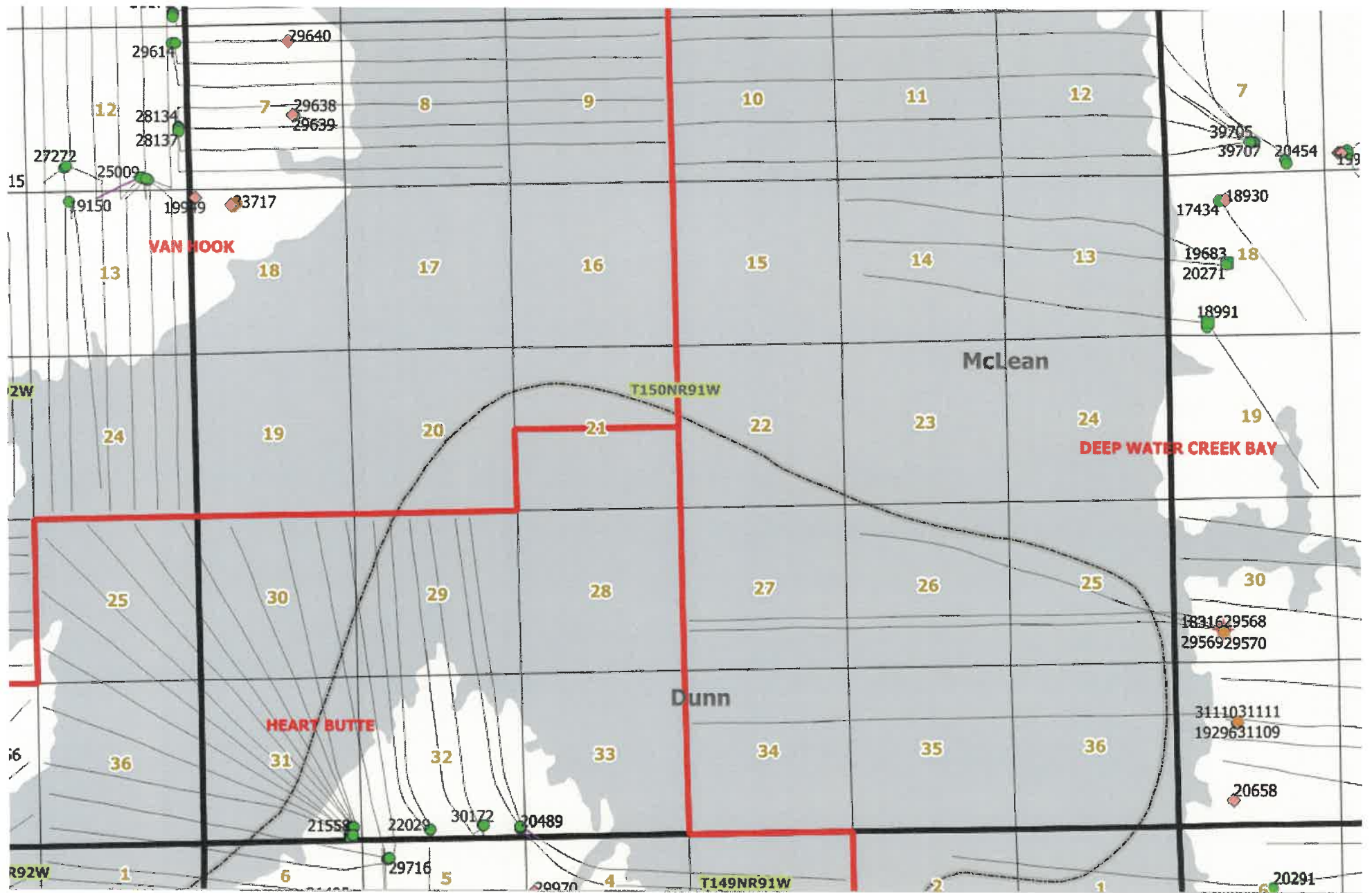


- Sections
- Townships
- City Boundary
- Surface Trust Land
- Bureau of Land Management
- Army Corps of Engineers
- Reservations



10/13/2025







**SPOTTED HAWK
DEVELOPMENT**

CASE No. 31357

INDUSTRIAL COMMISSION

STATE OF NORTH DAKOTA

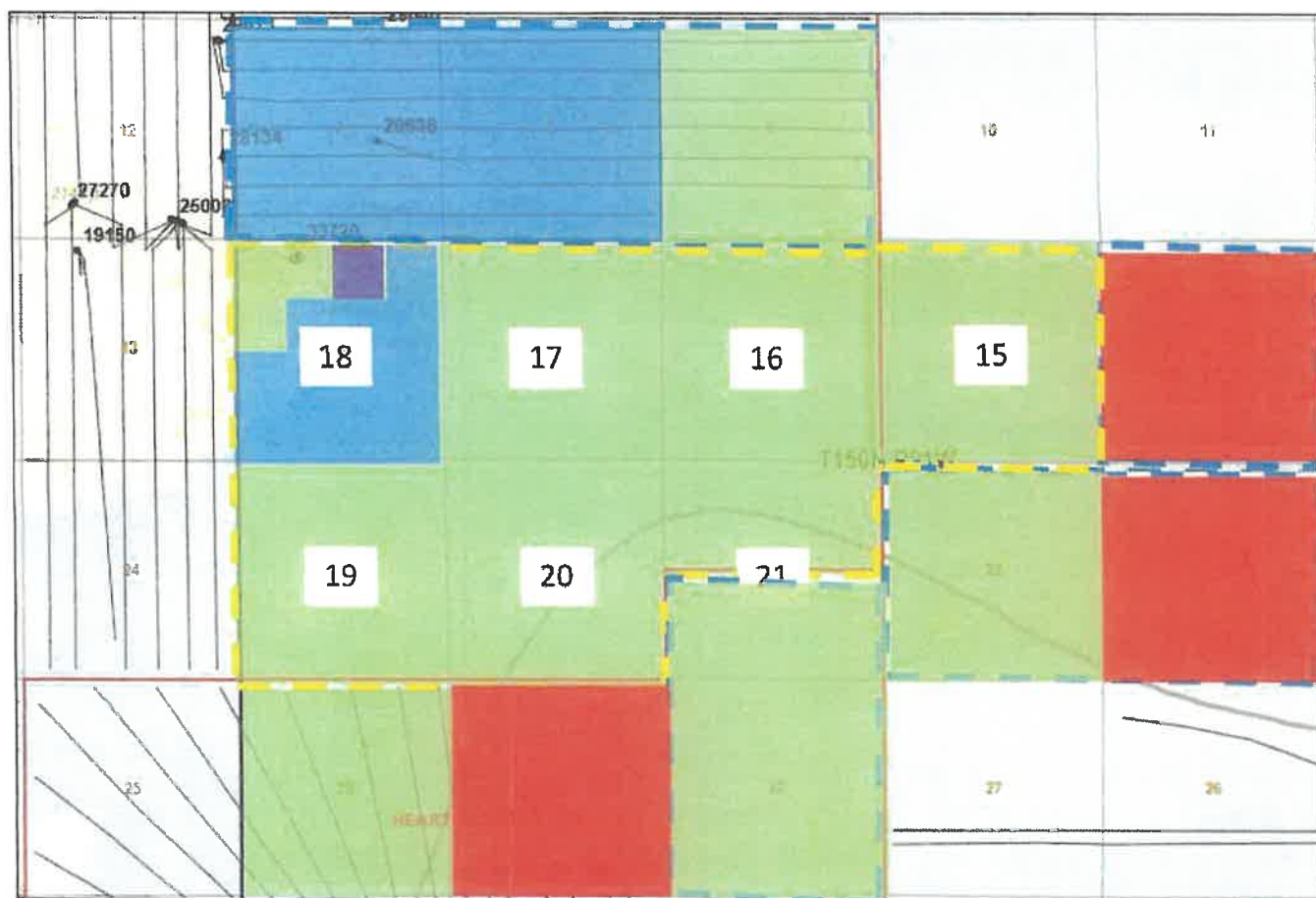
DATE 11/21/24 CASE NO 31357

Introduced By Spotted Hawk

Exhibit 2

Identified By Bell

PROPOSED UNIT WORKING INTEREST



SPOTTED HAWK 87.7% WI

DEVON 11.3% WI

OTHER < 1.0% WI

TOTAL 100% WI

-  Proposed Spacing Unit
-  Spotted Hawk
-  Devon
-  Chord
-  Other

EXHIBIT 2



**SPOTTED HAWK
DEVELOPMENT**

CASE No. 31357

INDUSTRIAL COMMISSION

STATE OF NORTH DAKOTA

DATE 11/21/24 CASE NO. 31357

Introduced By Spotted Hawk

Exhibit 14

Identified By Bell

CURRENT DSU, LEASEHOLD, AND WI MAP
SPOTTED HAWK IS THE LESSEE OF 100% OF SECTION 15

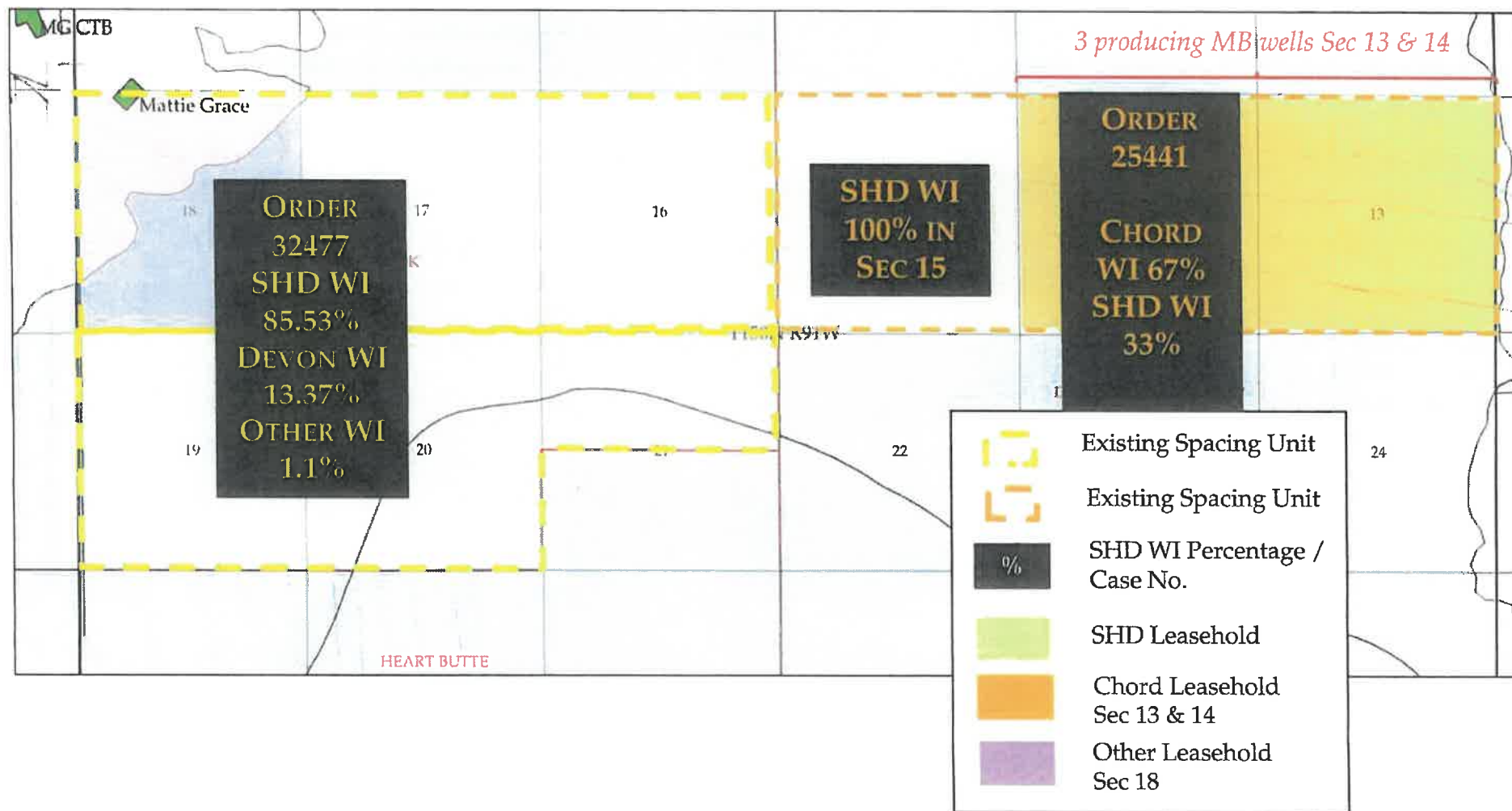


EXHIBIT 4



**SPOTTED HAWK
DEVELOPMENT**

CASE NO. 31357

FULL DEVELOPMENT PLAN

INDUSTRIAL COMMISSION

STATE OF NORTH DAKOTA

DATE 11/21/24 CASE NO. 31357

Introduced By Spotted Hawk

Exhibit #8

Identified By Neset

4 Middle Bakken wells starting at the 660 ft FNL, then MB well every 1320 ft

4 Three Forks wells starting at the 1320 ft FNL, then TF well every 1320 ft

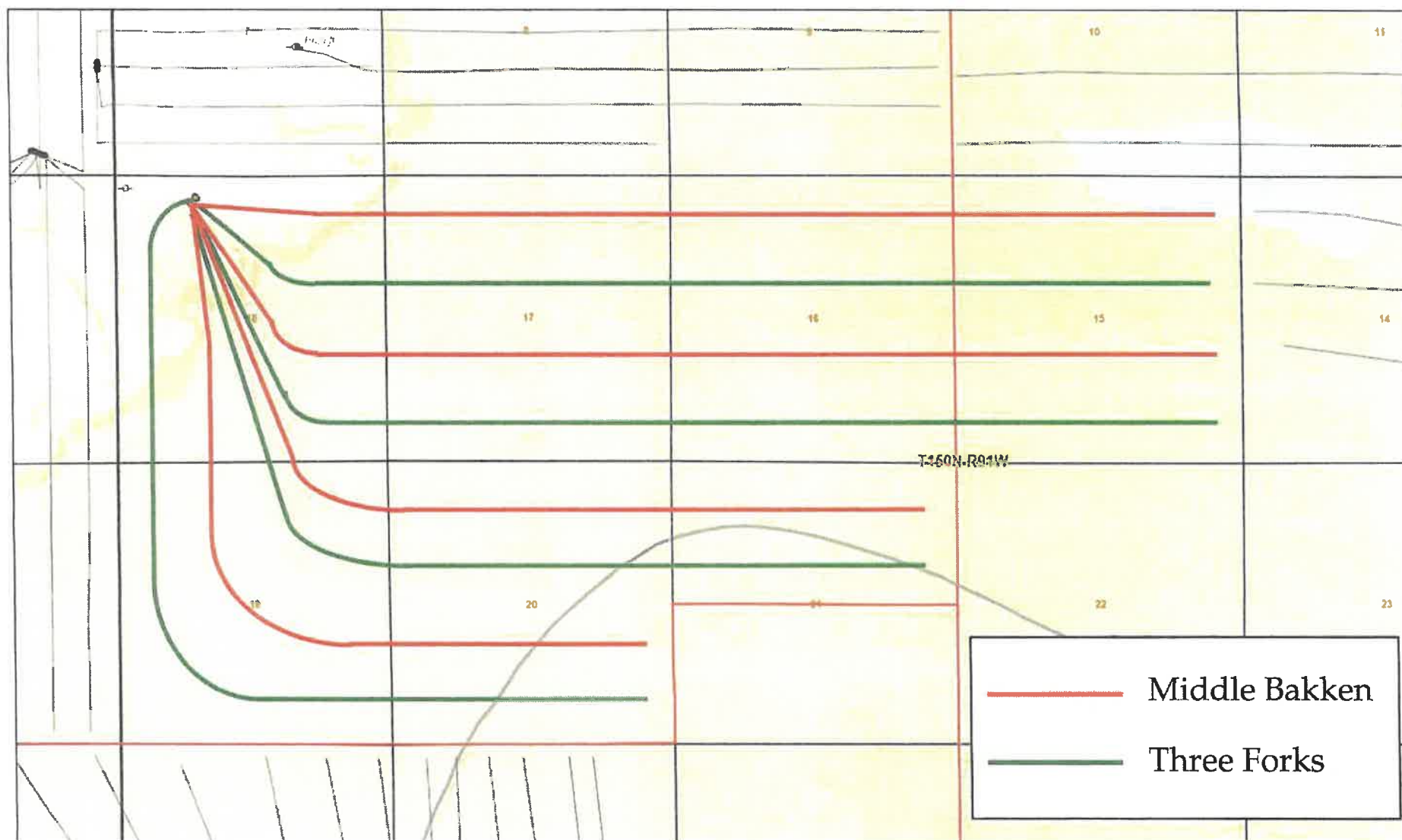


EXHIBIT 8



**SPOTTED HAWK
DEVELOPMENT**

CASE NO. 31357

INDUSTRIAL COMMISSION
STATE OF NORTH DAKOTA
DATE 11/21/24 CASE NO 31357
Initiated By Spotted Hawk
EXHIBIT #13
Identified By Neset

PREVIOUS SPACING UNITS

- Sections 19, 20 and N/2 of 21 were spaced prior to final determination of MG West surface location
- Revised spacing unit approved by NDIC on April 29, 2021
- Mattie Grace Pad cannot be enlarged due to cultural issues and can fit maximum 8 wells
- Well pad in 24-150-92 and 19-150-91 not possible because the sections are under the lake.
- Location in NW/4 of 13-150-92 creates 1-1.5+ mile deviation in the vertical prior to landing in Sections 18 and 19 of 150-91.
- Section 15-150-91 is effectively stranded.

LAYDOWN DSUS

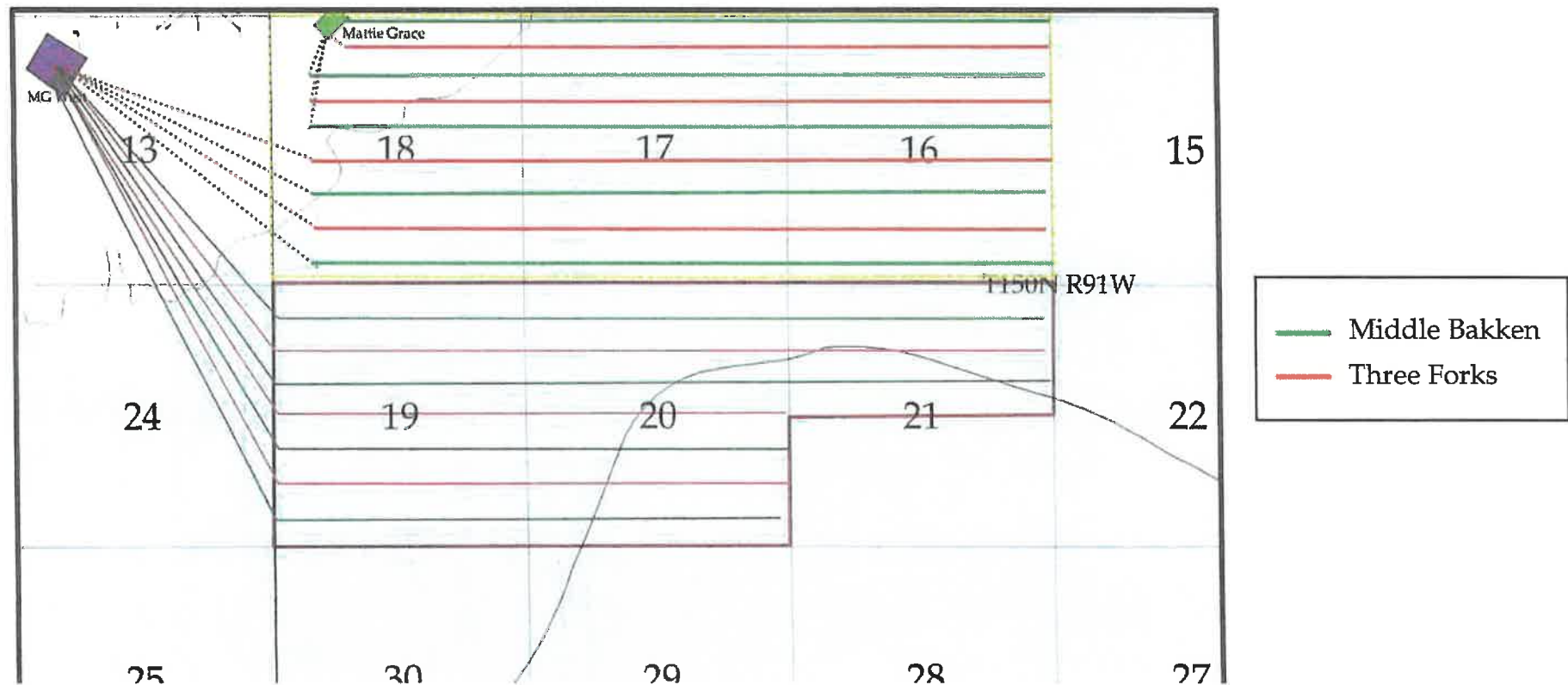
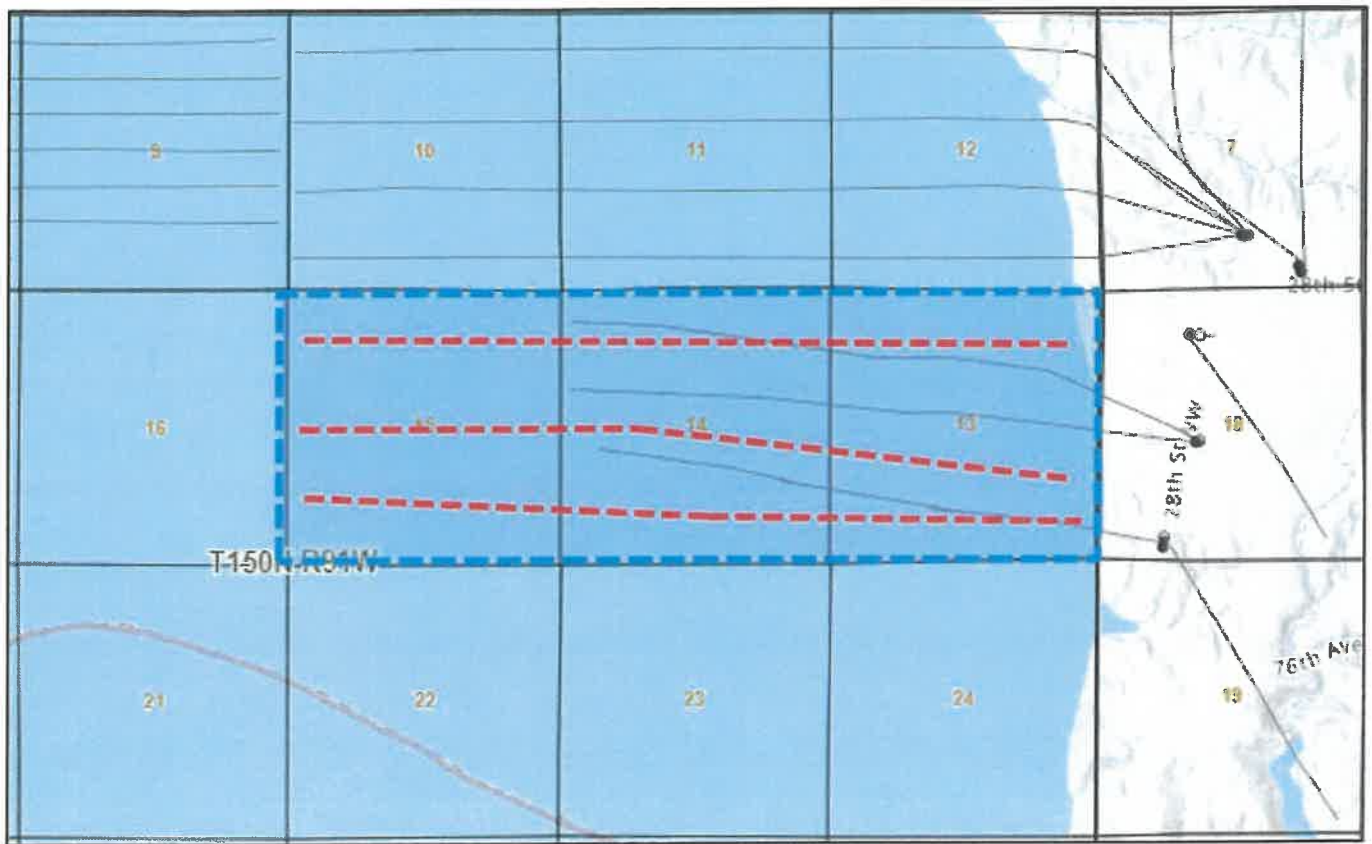


EXHIBIT 13



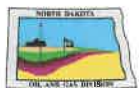
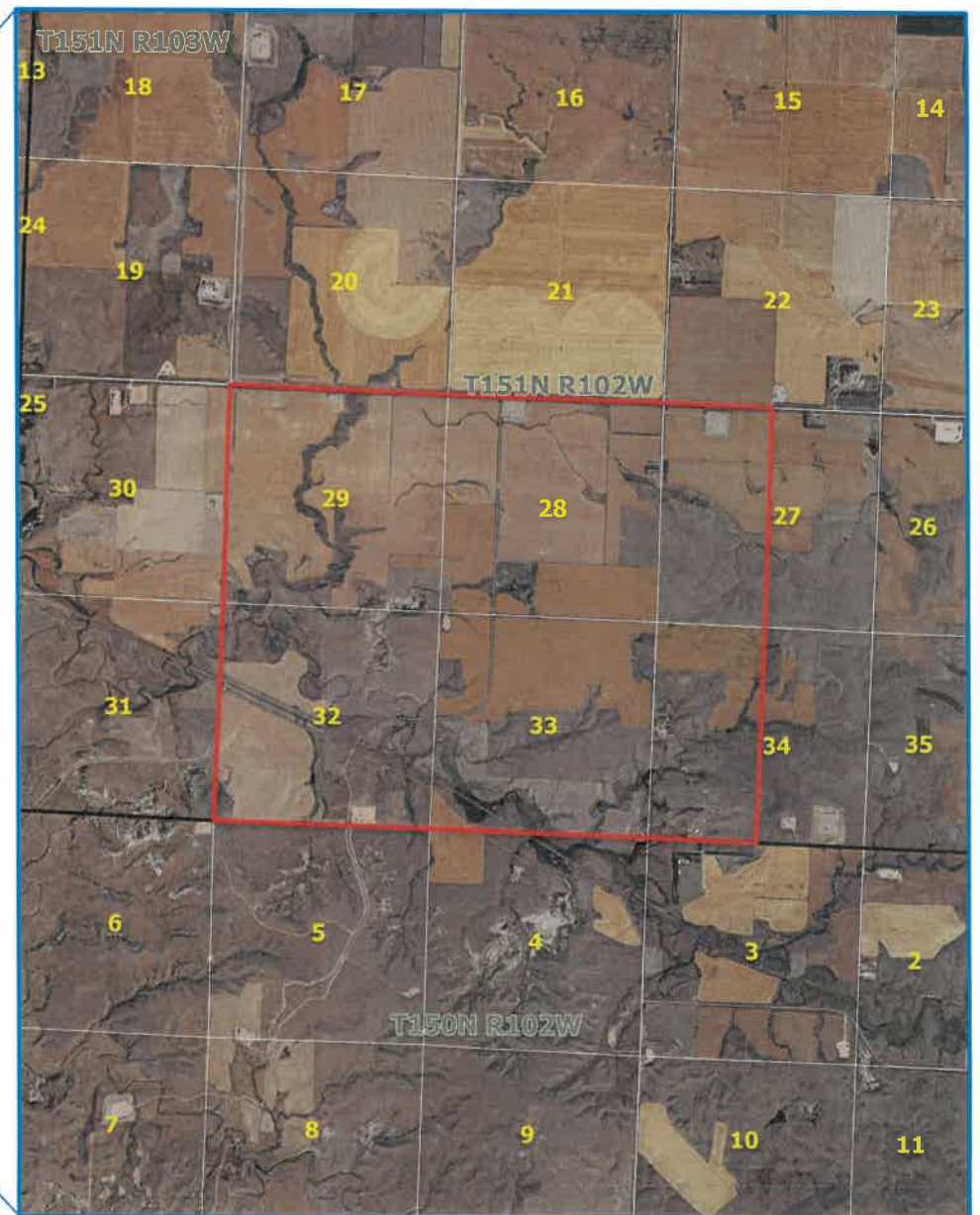
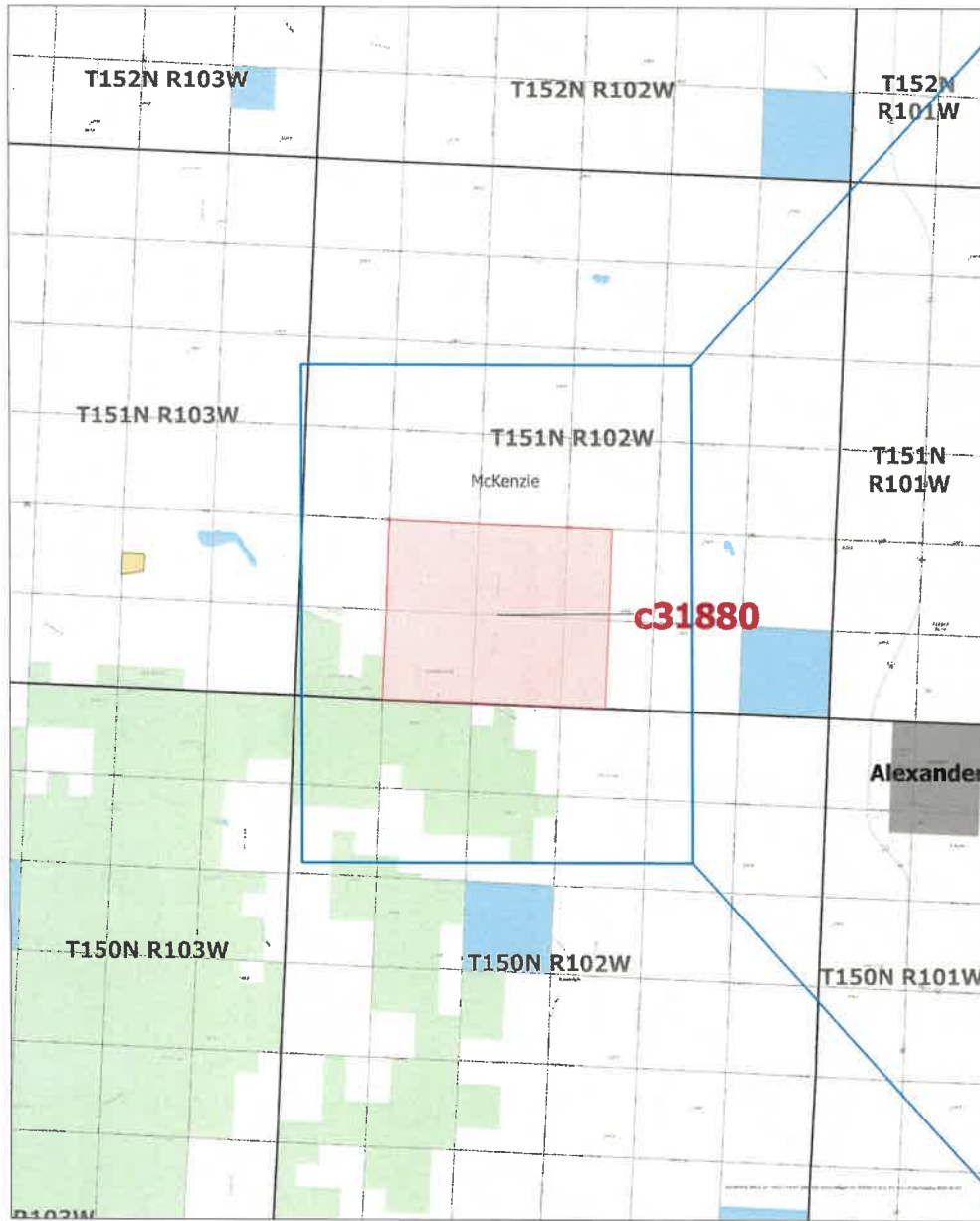
Planned
Development

1920 DSU

INDUSTRIAL COMMISSION
STATE OF NORTH DAKOTA
DATE 11/21/24 CASE NO. 31357
Introduced By Oasis
Exhibit E-1
Identified By Tomova Medina

Case 31357
November 21, 2024
Exhibit E-1

Industrial Commission c31880



10/13/2025

Sections
Townships

City Boundary
Surface Trust Land

Bureau of Land Management
National Grasslands



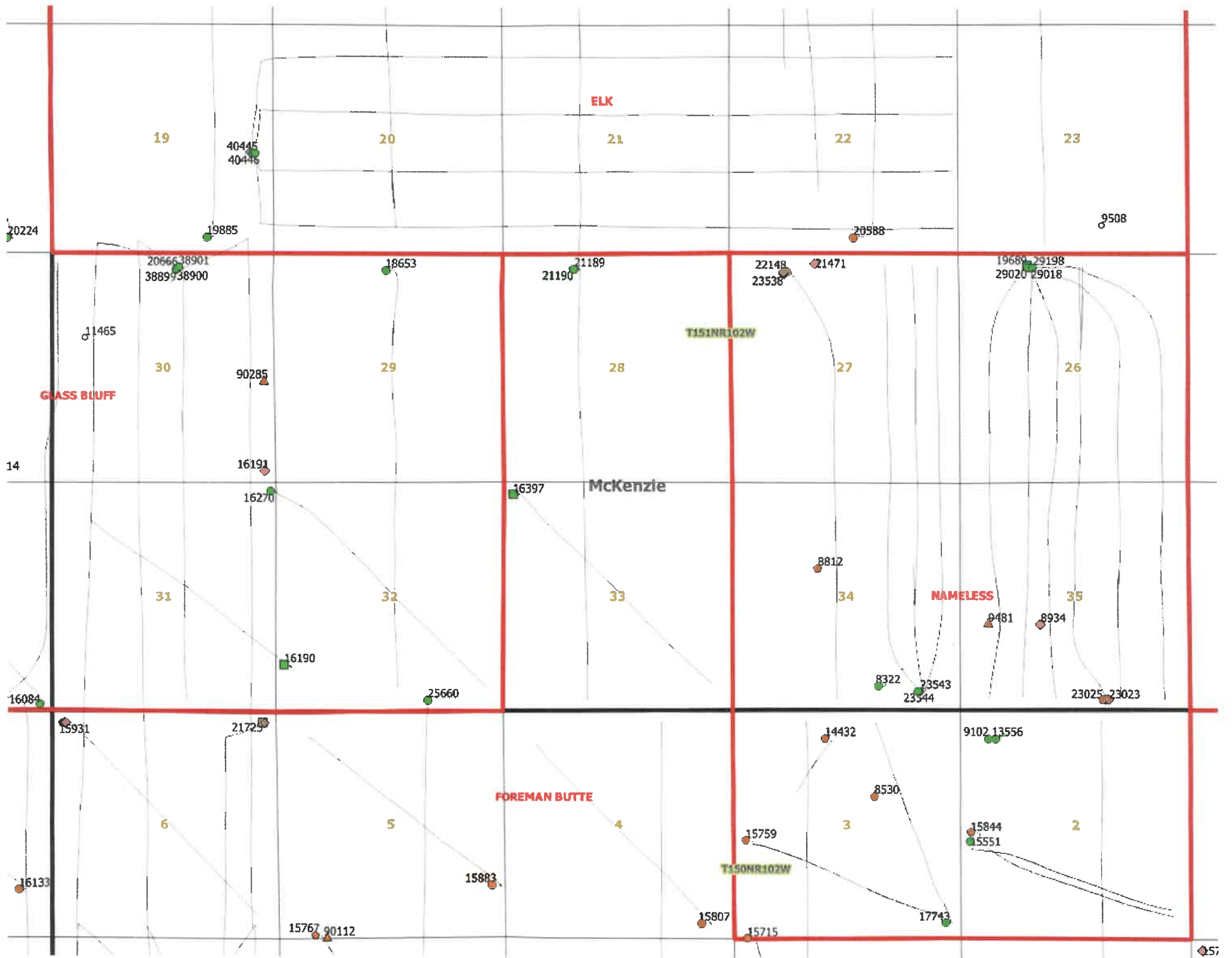
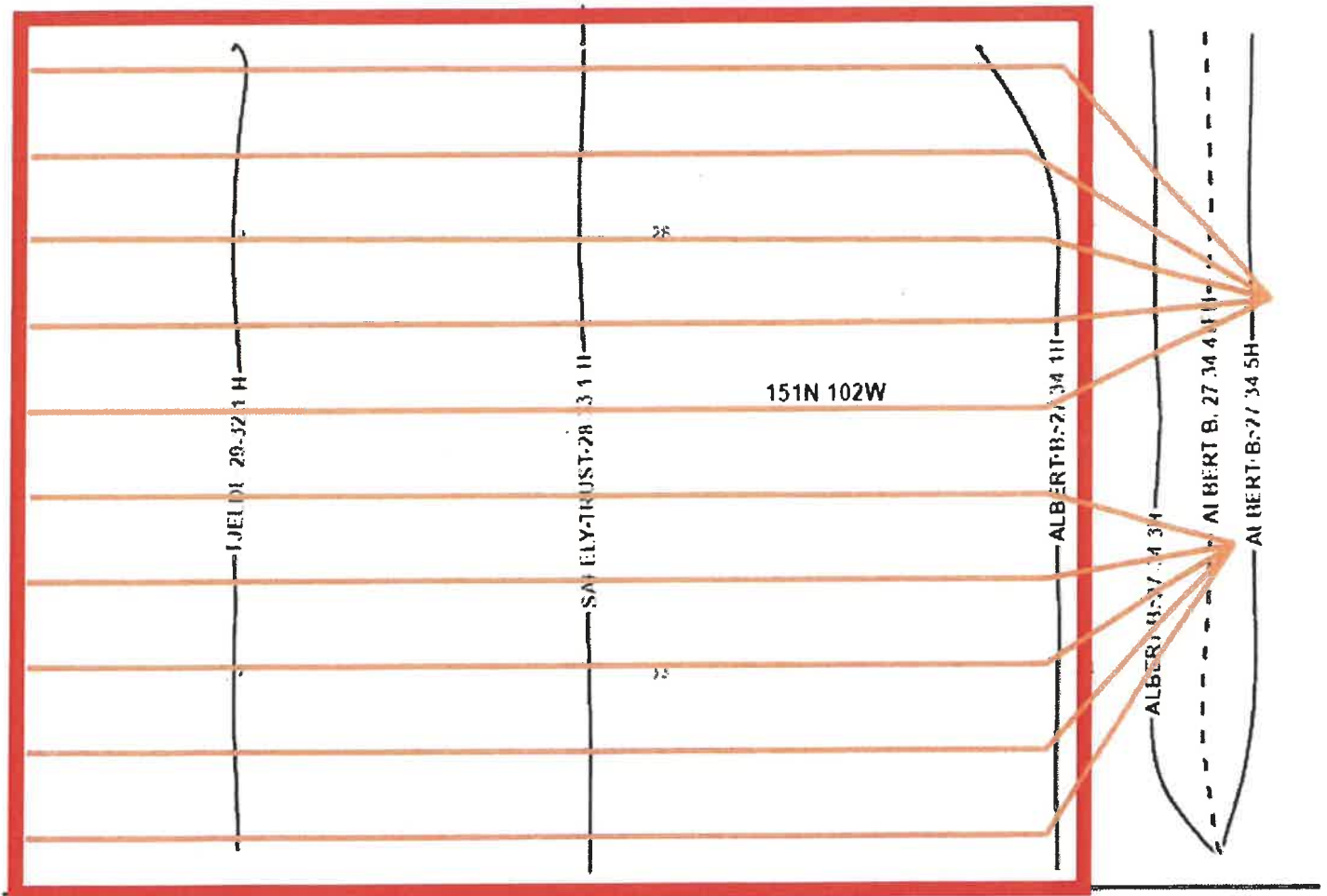


Exhibit E-1
Proposed Directional Well Plot

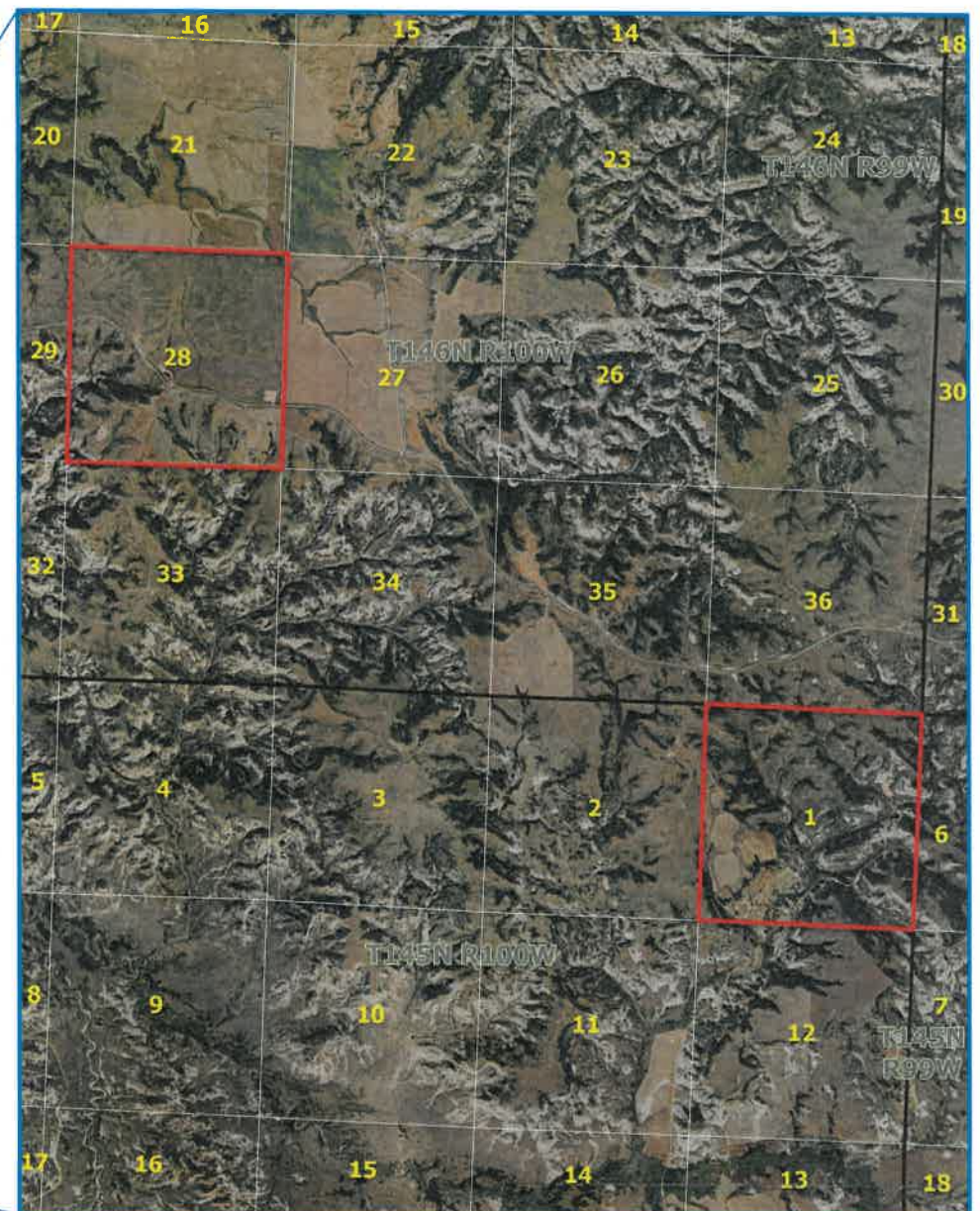
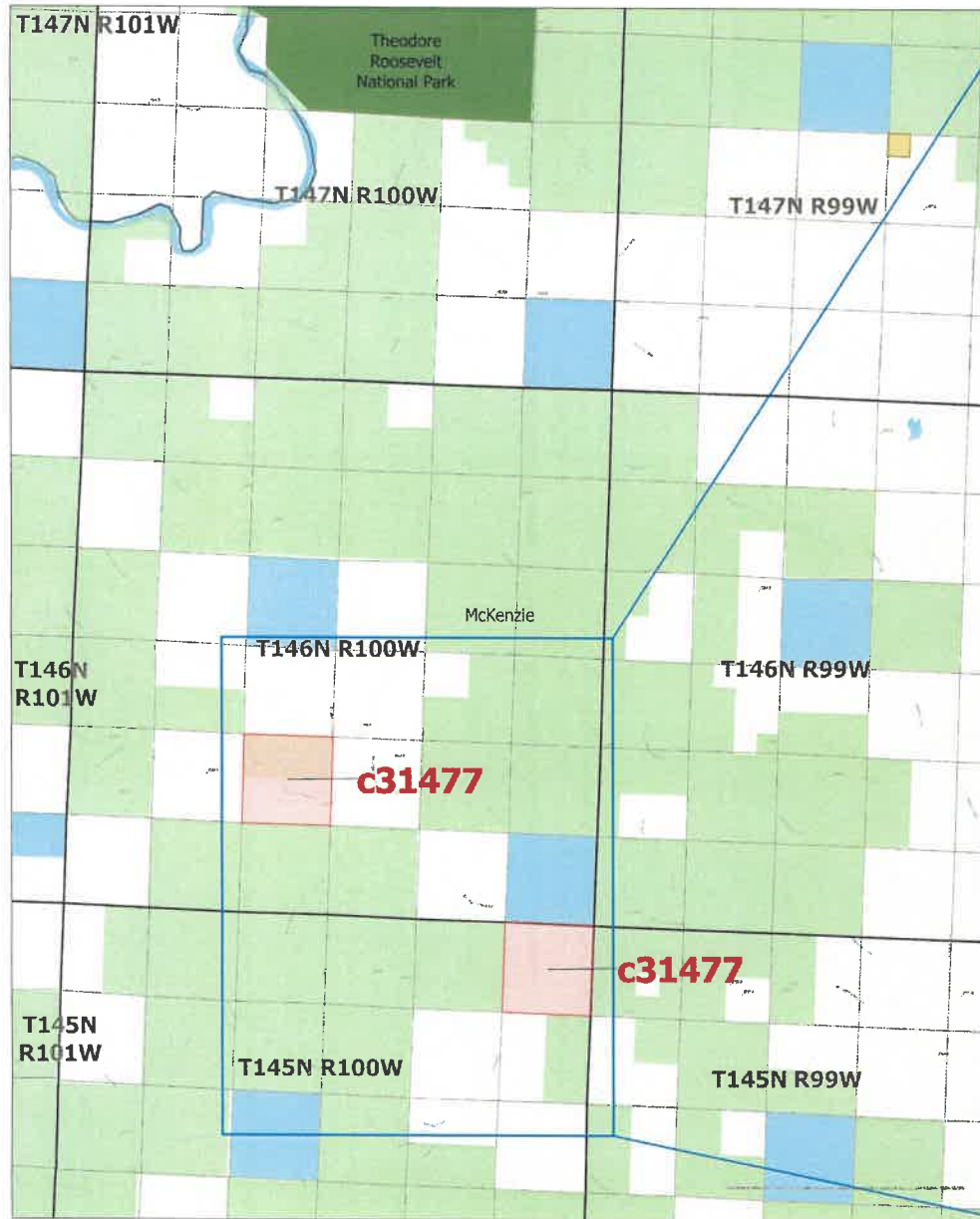
Proposed 3200-ac Spacing Unit(s)
all of Sections 28,29,32 & 33, W/2 of section 34 and 27
Township 151 North, Range 102 West



- Existing Middle Bakken Well
- - - Existing Three Forks Well
- Proposed Middle Bakken Well

INDUSTRIAL COMMISSION
STATE OF NORTH DAKOTA
DATE 7/24/25 CASE NO. 31880
INTRODUCED BY Devon
EXHIBIT e-1
IDENTIFIED BY Luna

Industrial Commission c31477



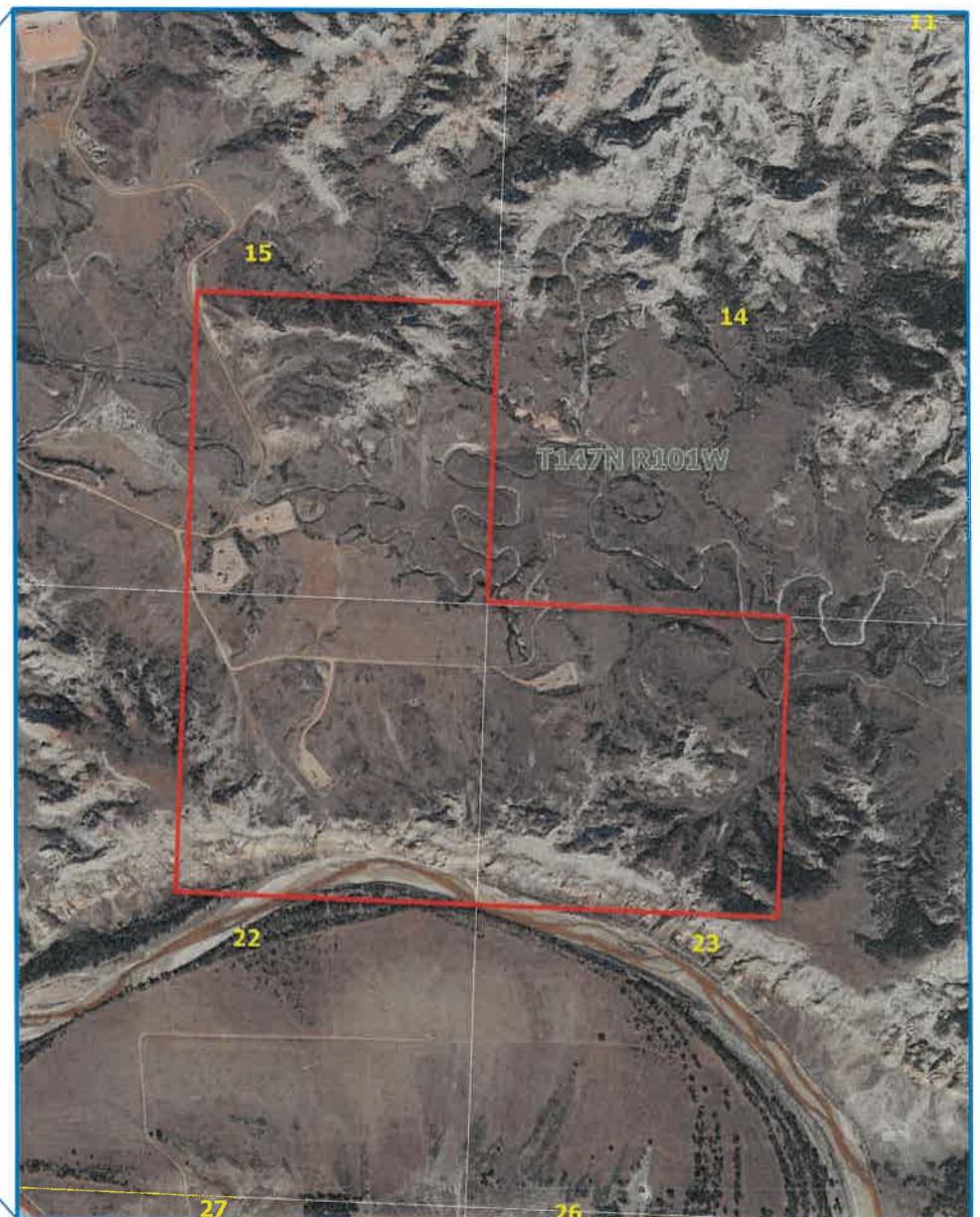
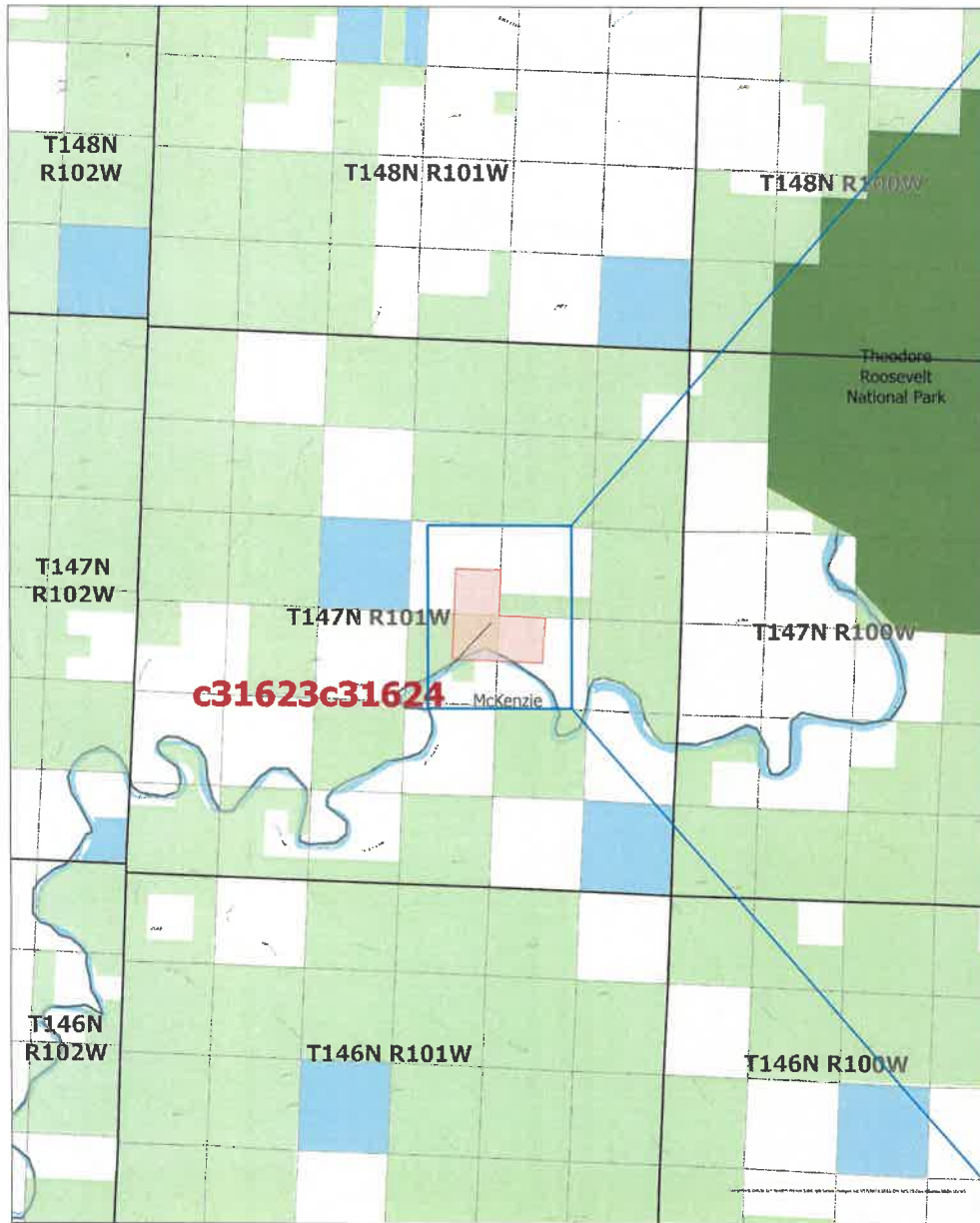
10/13/2025

Sections
Townships

Surface Trust Land
Bureau of Land Management

National Parks
National Grasslands





10/13/2025



Sections
Townships



Surface Trust Land
National Parks

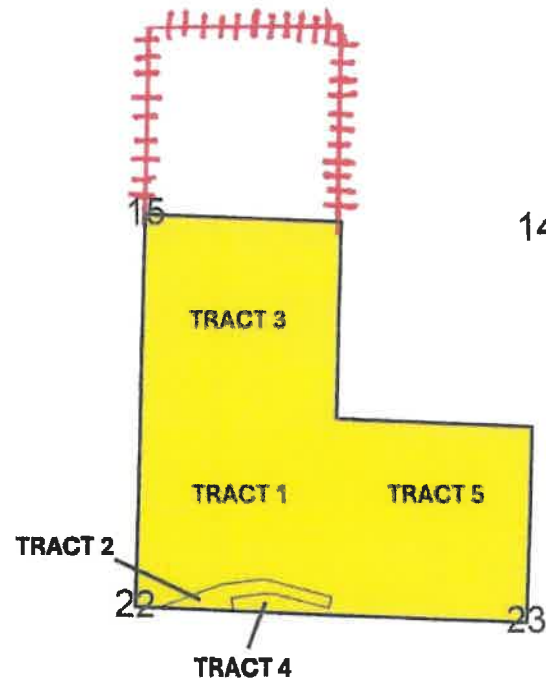


National Grasslands



SUPPLEMENTAL EXHIBIT 3

T147N R101W



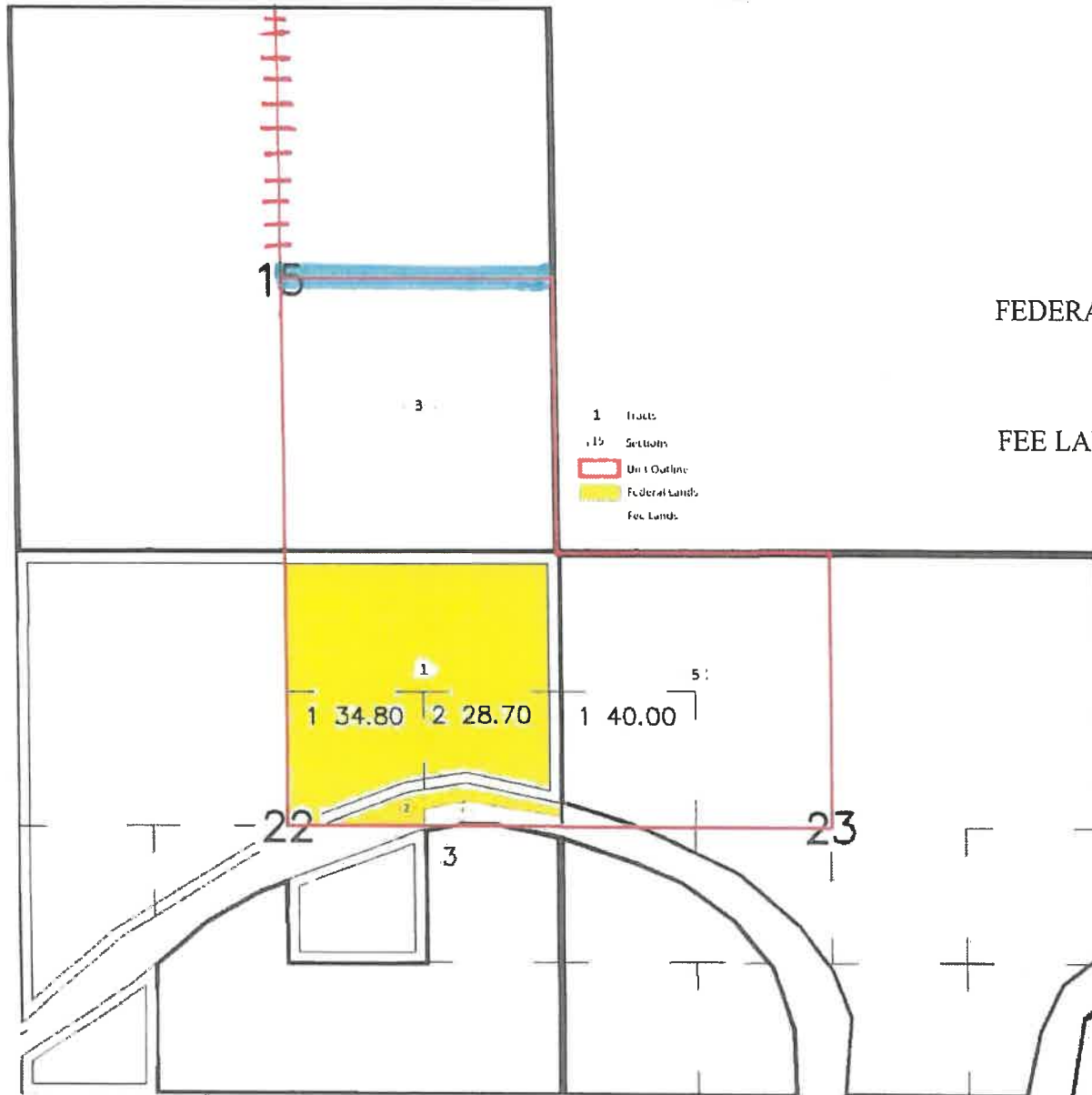
INDUSTRIAL COMMISSION
STATE OF NORTH DAKOTA
DATE 4/25/25 CASE NO. 31623
Introduced By Cobra
Exhibit Supp 3
Identified By Hatley



SUPPLEMENTAL EXHIBIT A

BULL MOOSE-DUPEROW UNIT AREA OUTLINE

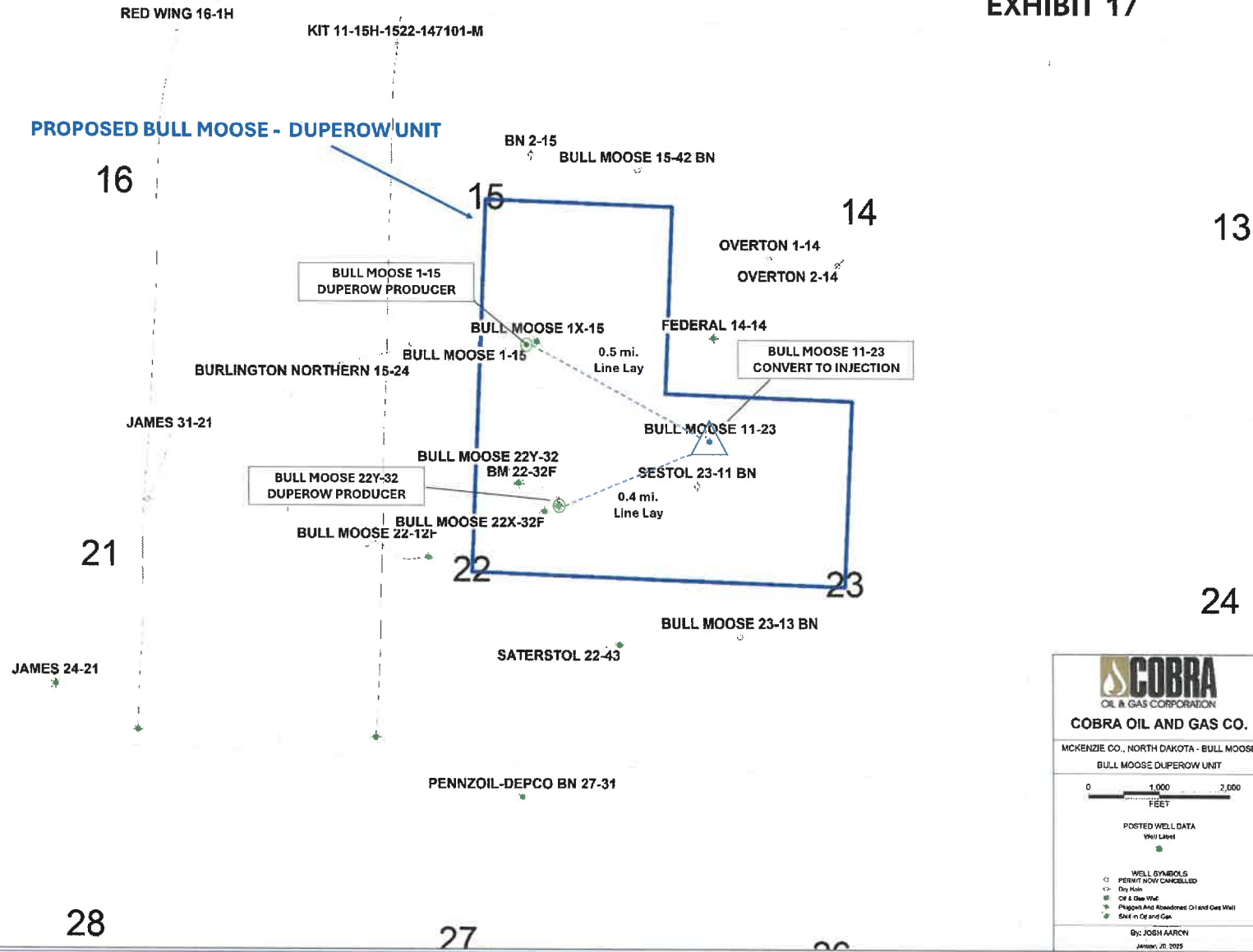
Township 147 North, Range 101 West of the 5th P.M.



	GROSS ACRES	PERCENTAGE
FEDERAL LANDS	154.140	<u>32.1125%</u> <u>24.284%</u>
FEE LANDS	<u>325.860</u> <u>485.860</u>	<u>67.8875%</u> <u>75.916%</u>
	<u>480.000</u> <u>640.000</u>	100.0000%

INDUSTRIAL COMMISSION
STATE OF NORTH DAKOTA
DATE 4/15/25 CASE NO. 31623
Introduced By Cobra
Exhibit Supp Ex A
Identified By Hatley

EXHIBIT 17





OIL AND GAS RESEARCH PROGRAM PROJECT MANAGEMENT REPORT

Jordan Kannianen, Deputy Executive Director, NDIC

October 2025

NORTH
Dakota
Be Legendary.™

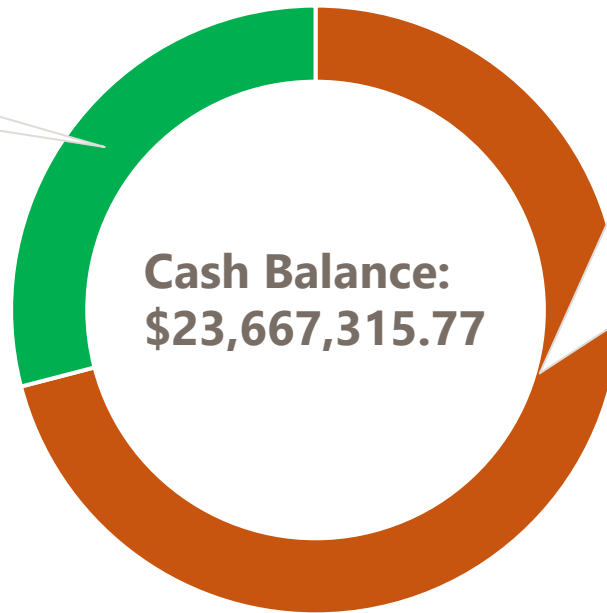
OIL AND GAS RESEARCH FUND BALANCE

OCTOBER 10, 2025

Oil and Gas Research Fund

*Estimated based on forecasted
Sept & Oct allocations

***\$7,658,493.86**



■ Committed ■ Uncommitted

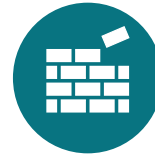
\$16,008,821.91

\$259,975.00 admin and one-time grant management
\$600,000 pipeline authority
\$2,228,645.94 iPipe
\$2,530,023.57 Natural Gas Capture
\$10,390,177.40 outstanding grant commitments



Funding Source:

- \$17.5 million oil production and extraction tax
- \$25 million SIIF for EOR



135 Cumulative Projects



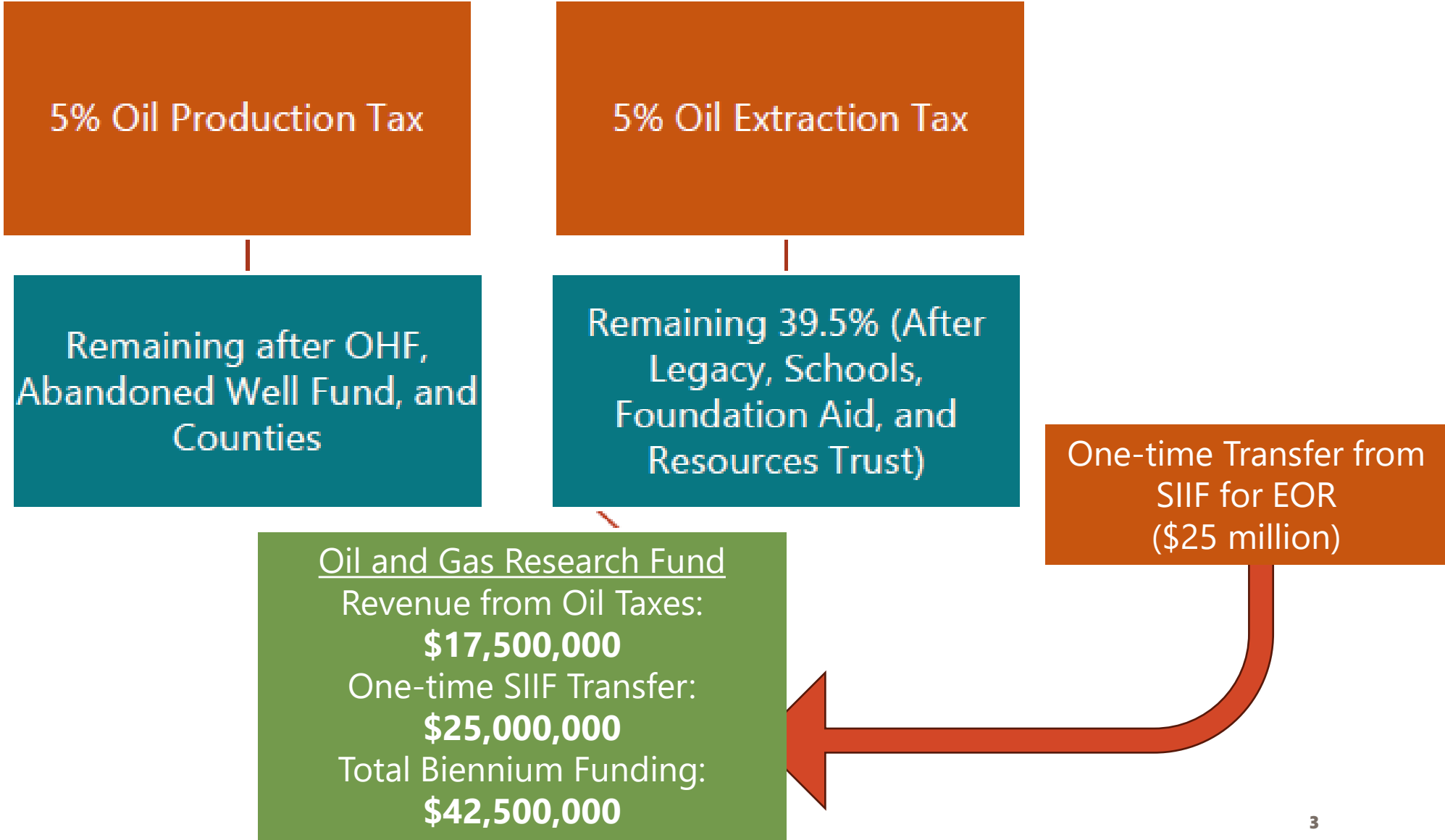
12 Active Projects



Cumulative Value:

- \$100.05 million granted
- \$544.78 million project value

2025-2027 BIENNIUM FUNDING:



DIRECTOR'S COMMENTS**G-062-L****Large-Scale Hydrocarbon Gas Injection EOR Pilot to Inform Future CO2 EOR in the Bakken**

Submitted by: Chord Energy
 Principal Investigator: Arvo Buck
 Request for: \$13,998,200
 Total Project Costs: \$38,632,967
 Duration: 2 years

Description of the Project:

The objective is to complete the necessary modifications to the originally planned EOR modeling and simulations, injection scheme design, operational planning, permitting, and reservoir surveillance to successfully transition from a purely CO2 injectate stream to a hydrocarbon gas stream for a 20-month multiwell, multicycle EOR pilot.

The EOR pilot will be located in the Indian Butte Area of the Bakken, McKenzie County, North Dakota. The proposed project intends to use pairs of wells for injection, oil production, and reservoir surveillance throughout the project. Additional offset wells will be monitored for production responses after injection commences. The two HnP wells along with the other four wells on the DSU pad are currently drilled and will be completed and put in production prior to the injection project commencing.

Execution of the pilot test activities will help demonstrate a pathway towards commercial-scale deployment of Bakken EOR for hydrocarbon and CO2 injectates.

Technical Reviewers' Recommendations: 1 Fund, 2 Funding to be Considered

Director's Recommendation: Recommend funding in the amount of \$13,298,290

Conflicts of Interest: None

Council Motion: Fund in the amount of \$13,298,290 (5% less than the original request). In addition, funding for 100% of the total request contingent upon additional funding from the US Department of Energy.

Vote: 6 yes; 0 nay, absent and not voting

Technical Reviewers' Rating Summary

Proposal Number	G-62-L	Application Title	"Large-Scale Hydrocar	Submitted By
Chord Energy	Request For	\$13,998,200.00	Total Project Costs	
\$38,632,967.00				

Section A. Scoring

Statement	Weighting Factor	G-62-L3	G-62-L1	G-62-L2	Average Weighted Score
1. Objectives	9	4	4	4	36
2. Achievability	7	5	3	4	28
3. Methodology	8	4	4	3	24
4. Contribution	8	4	4	5	32
5. Awareness / Background	5	4	5	3	20
6. Project Management	3	3	4	3	9
7. Equipment / Facilities	2	3	4	5	8
8. Value / Industry - Budget	4	4	4	5	16
9. Financial Match - Budget	4	5	5	5	20
Average Weighted Score		206	202	202	203

Total: 50

250 possible points

OVERALL RECOMMENDATION

FUND			X
FUNDING TO BE CONSIDERED	X	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 objectives of this proposal align very well with the legislative intent in SB 2014

- Reviewer: G-62-L3

- Rating: 4

The pivot from CO₂ to hydrocarbon injectate is well-explained and justified. The proposal aligns with NDIC's EOR goals.

- Reviewer: G-62-L1

- Rating: 4

The objective is very clear that the applicant wants to complete the necessary modifications, modeling, etc. to transition from what they originally thought would be a CO₂ project to a hydrocarbon project. It would have helped to put an objective surrounding the actual application to the huff n puff process as it being a high priority result.

- Reviewer: G-62-L2

- Rating: 4

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

The proposed timetable and budget are based on extensive partner experience with previous projects. They are realistic and will deliver some injection rate and pressure results by the 2027 legislative assembly.

- Reviewer: G-62-L3

- Rating: 5

The project is ambitious but feasible given Chord's scale and EERC's support. CO₂ supply constraints are a known risk.

- Reviewer: G-62-L1

- Rating: 3

Most of the risk of not meeting the timeline and budget associated in the application comes down to equipment procurement, injectate procurement, permitting, and any unforeseen results with the lab testing and modeling that would be cause for concern leading to a reassessment of the project.

- Reviewer: G-62-L2

- Rating: 4

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

The applicant is leveraging lessons learned by EERC from previous projects to design a project methodology that increases the probability of success.

- Reviewer: G-62-L3

- Rating: 4

The multiwell HnP design, reservoir surveillance, and modeling are sound. The adaptation to hydrocarbon injectate is pragmatic.

- Reviewer: G-62-L1

- Rating: 4

There have been a number of huff n puffs that have been done throughout unconventional basins in the United States as well as some in the Bakken. Having a paragraph or even a few sentences on what Chord is doing differently to be successful or lessons learned from review of other huff n puff pilot projects would have helped differentiate Chord's project from the rest of the industry.

- Reviewer: G-62-L2

- 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:

The scientific and technical information from this project could lead to large scale implementation of Bakken and Three Forks EOR. At a minimum the project will greatly improve future research projects. Project success will mean decades of additional oil and gas production in the state.

- Reviewer: G-62-L3

- Rating: 4

The pilot could inform future CO₂ EOR deployment and extend Bakken production life. It leverages DOE funding effectively.

- Reviewer: G-62-L1

- Rating: 4

This could have a multi-billion barrel impact on the state of North Dakota if 1.) the pilot is successful and 2.) if it can be implemented across a sizeable portion of the Bakken.

- Reviewer: G-62-L2

- Rating: 5

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 project partner (EERC) has extensive experience in the area of this research project and can leverage lessons learned from previous projects to greatly increase the probability of success.

- Reviewer: G-62-L3

- Rating: 4

Chord and EERC bring deep expertise. The team includes leaders in EOR, CCS, and Bakken development.

- Reviewer: G-62-L1

- Rating: 5

There have been a number of huff n puff projects across the United States in unconventional reservoirs. This should have been referenced and discussed in greater detail. I would also imagine that the EERC has tested multiple injectates within a Bakken core at their lab to determine the best for EOR. If not, then this is needed from a research perspective to narrow down what injectate has the largest impact for recovering additional oil paired along with economics. More detail and background on what has been done, what is available, what needs additional testing research, etc. would have been helpful.

- Reviewer: G-62-L2

- Rating: 3

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 project plans are based on EERC experience with similar projects. Extensive infrastructure has to be built and gas acquisition and marketing agreements have to be negotiated. Funding should be contingent on written confirmation from DOE that the hydrocarbon gas stream used for the pilot including a minor concentration of CO₂ will satisfy the contractual obligation to DOE to evaluate the potential effects of CO₂ injection on a Bakken reservoir. An alternative would be to partner with NDeV-Exiel to generate enough CO₂ on site to satisfy the DOE requirements.

- Reviewer: G-62-L3

- Rating: 3

The plan includes clear milestones, deliverables, and reporting. Integration between Chord and EERC is well-defined.

- Reviewer: G-62-L1

- Rating: 4

The management plan, milestones, schedule, financial plan, and communications is straightforward. It was slightly less clear with the budget breakdown table if Chord is paying for the \$24,634,767 and the NDIC-OGRP is paying an additional \$13,998,200. Based on the commentary throughout the document, my assumption is Chord would be paying the difference of \$24,634,767 - \$13,998,200, which would leave Chord with \$10,636,567.

- Reviewer: G-62-L2

- Rating: 3

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

This proposal is based on EERC experience with previous projects. The budget should be adjusted to avoid NDIC purchase of gas for injection and the potential legal, royalty, tax, and ownership issues that could cause. I would like to see NDIC and applicant funds redistributed to reduce NDIC equipment/CAPEX purchases/ownership and increase NDIC share of equipment leases and OPEX.

- Reviewer: G-62-L3

- Rating: 3

The budget includes detailed infrastructure needs, with rationale for each item. Hydrocarbon injectate costs are explained.

- Reviewer: G-62-L1

- Rating: 4

With a huff n puff, the purchase of equipment is extremely well justified.

- Reviewer: G-62-L2

- Rating: 5

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

The availability of lessons learned by EERC from the previous projects and EERC geological characterization work accelerate the project timeline and provide a very robust budget.

- Reviewer: G-62-L3

- Rating: 4

The \$38.6M budget is high, but the DOE funding and Chord’s match make it a strong value proposition.

- Reviewer: G-62-L1

- Rating: 4

This is exceptionally good value given DOE funding and EERC backing. Field testing is needed in order to apply lab results and simulation/modeling to a real world scenario.

- Reviewer: G-62-L2

- Rating: 5

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

The experience of EERC along with the financial position of the applicant provide a very robust matching fund budget. Funding should be contingent on written confirmation from DOE that the hydrocarbon gas stream used for the pilot including a minor concentration of CO₂ will satisfy the contractual obligation to DOE to evaluate the potential effects of CO₂ injection on a Bakken reservoir.

- Reviewer: G-62-L3

- Rating: 5

Chord provides over 63% of the total cost, exceeding match requirements.

- Reviewer: G-62-L1

- Rating: 5

The support from other sources is of very high value. Chord and the DOE will contribute ~64% of the project costs with the NDIC-OGRP contributing the remaining ~36%.

- Reviewer: G-62-L2

- Rating: 5

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

The applicant has the scalability to improve the probability of success with this project. The partner EERC has the knowledge and experience to increase the probability of success. The location of the proposed project creates some uncertainty regarding the location and availability of gas gathering, processing, and supply infrastructure in the area.

- Reviewer: G-62-L3

This proposal is strategically important, bridging the gap between current hydrocarbon EOR and future CO₂ deployment. It leverages federal funding, aligns with NDIC's EOR initiative, and could unlock billions of barrels in the Bakken. The technical team is highly qualified, and the infrastructure plan is robust.

- Reviewer: G-62-L1

Projects like the one Chord has proposed are needed to gain the necessary data, analyze the data, and modify in a way that becomes commercially viable across industry. With dwindling inventory for new drills across the United States unconventional plays, industry needs to move to the next phase and utilize an existing assets and infrastructure to increase oil recovery. This project does exactly that and uses a strong technical framework to lab test injectates to find most viable, model/simulate, and then test and monitor. The small flaws in the application/project were: 1.) not expanding on what has been done by industry to date in either the Bakken or the broader United States unconventional plays, which may or may not have altered the approach to the project and 2.) not fully laying out the huff n puff wells, location in DSU, and pattern in map detail.

- Reviewer: G-62-L2

Submit Summary

ABSTRACT

Objective: The “Bakken CO₂ EOR and Storage Field Laboratory” (BCO₂EORFL) was established in September 2024, to conduct lab, modeling, and field-based activities to show that CO₂ injected into a Bakken reservoir will result in incremental oil recovery. The center piece of the original BCO₂EORFL work plan is an 18-month CO₂ injection pilot for EOR. This pilot is the first to comprehensively address all technical and operational challenges that limited previous pilots full potential. The objective of this proposal is to provide additional resources that will enable Chord Energy to fully achieve the BCO₂EORFL goal of demonstrating commercial viability of Bakken EOR. This EOR pilot is the fastest and surest path to economic EOR success for North Dakota and its O&G Operators. Unfortunately, to achieve the pilot’s ambitions, Chord had to adjust from a CO₂ injection plan to a mostly a hydrocarbon based injectable solution due to lack of available CO₂ supply. Hydrocarbon injectant and CO₂ are similar enough for EOR to allow for the results from a hydrocarbon-based EOR pilot to be calibrated to predict the effects of CO₂ under the same reservoir conditions. This indicates that the results of an EOR pilot that uses hydrocarbons can be directly applied to predicting the results of future EOR operations that use CO₂. In addition to higher injectable fluid costs, base costs for the project have fundamentally exceeded original expectations. This is largely due to refining/changing scope now that a drilling spacing unit (DSU) has been chosen. Chord is currently working through understanding surface processes and necessary surface facilities to successfully execute this EOR pilot. **Expected Results:** Execution of the pilot test activities will help demonstrate a pathway towards commercial-scale deployment of Bakken EOR for hydrocarbon and CO₂ injectates. **Duration:** 24 months (January 1, 2026 – December 31, 2027). **Total Cost:** The total value of the project is \$38,632,967. The OGRP request is for \$13,998,200. Chord Energy will provide cost-share commitments. **Participants:** Chord Energy and EERC.

DIRECTOR'S COMMENTS**G-062-I****Bakken Optimization Program (BPOP) 5.0**

Submitted by: Energy & Environmental Research Center (EERC)

Principal Investigator: James Sorenson

Request for: \$6,000,000

Total Project Costs: \$12,030.206

Duration: 2 years

Description of the Project:

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.

The objective is 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

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.

Technical Reviewers' Recommendations: 2 Fund, 1 Funding to be Considered**Director's Recommendation:** Recommend funding in the amount of \$4,000,000**Conflicts of Interest:** None

Council Motion: Fund in the amount of \$5,000,000 (Approx. 17% less than the original request). In addition, funding for 100% of the total request contingent upon additional funding from the US Department of Energy.

Vote: 6 yes; 0 nay, absent and not voting

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

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.

DIRECTOR'S COMMENTS**G-062-O****Proposal for a Surfactant-Based EOR Pilot Testing Program**

Submitted by: Devon

Principal Investigator: Brad Musgrove

Request for: \$1,535,000

Total Project Costs: \$3,370,000

Duration: 2 years

Description of the Project:

Devon Energy proposes a testing campaign followed by a field pilot to demonstrate the technical and economic viability of surfactant-based Enhanced Oil Recovery (EOR) in the Williston Basin, North Dakota. The project will study and select the appropriate surfactant and methodology, then proceed to inject a surfactant solution targeting the Middle Bakken and/or Three Forks formations on three wells. The objective is to increase oil recovery by mobilizing residual hydrocarbons, optimize operational parameters, and provide a scalable blueprint for broader EOR deployment in North Dakota. The pilot leverages Devon's infrastructure and technical expertise, with a strong focus on risk management, stakeholder engagement, and cost-sharing.

Technical Reviewers' Recommendations: 1 Fund, 2 Funding to be Considered**Director's Recommendation:** Recommend funding in the amount of \$1,535,000**Conflicts of Interest:** None

Council Motion: Fund in the amount of \$1,535,000 (5% less than the original request). In addition, funding for 100% of the total request contingent upon additional funding from the US Department of Energy.

Vote: 6 yes; 0 nay, absent and not voting

Technical Reviewers' Rating Summary

Proposal Number **G-62-0** Application Title **Proposal for Surfactant-Based EC** Submitted
 By **Devon** Request For **\$1,535,000.00** Total Project Costs
\$3,370,000.00

Section A. Scoring

Statement	Weighting Factor	G-62-O1	G-62-O2	G-62-O3	Average Weighted Score
1. Objectives	9	3	5	4	36
2. Achievability	7	4	4	3	21
3. Methodology	8	3	3	3	24
4. Contribution	8	4	5	4	32
5. Awareness / Background	5	4	3	3	15
6. Project Management	3	2	3	2	6
7. Equipment / Facilities	2	3	5	3	6
8. Value / Industry - Budget	4	3	5	4	16
9. Financial Match - Budget	4	3	3	4	12
Average Weighted Score		167	203	172	180

Total: 50

250 possible points

OVERALL RECOMMENDATION

FUND

X

FUNDING TO BE CONSIDERED

X

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 proposal clearly defines its goal to evaluate surfactant-based EOR in the Middle Bakken and Three Forks formations. It aligns directly with NDIC's mission to enhance oil recovery, improve resource utilization, and support scalable technologies for North Dakota's unconventional reservoirs.

- Reviewer: G-62-O1

- Rating: 3

Devon was very clear and detailed in what in their standards of success that relate to the strategic objectives and technical approach summary.

- Reviewer: G-62-O2

- Rating: 5

The objectives of this proposal align very well with the legislative intent in SB 2014

- Reviewer: G-62-O3

- Rating: 4

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

The two-phase approach with lab screening followed by field pilot is well-structured and feasible within the 24-month timeline and \$3.37M budget. Devon's operational control and infrastructure readiness support successful execution.

- Reviewer: G-62-O1

- Rating: 4

The reason this is scored most likely achievable, is that a more specific/descriptive timeline was not included outside the cover page stating 24 months. If the phases were broken down into a duration as well, that would have pushed it to certainly achievable. The budget looks certainly achievable barring any increases in pumping equipment.

- Reviewer: G-62-O2

- Rating: 4

The proposed timetable and budget appear realistic and will deliver some results by the 2027 legislative assembly.

- Reviewer: G-62-O3

- Rating: 3

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

The methodology includes advanced lab testing (IFT, wettability, adsorption), core flood experiments, and field implementation with real-time diagnostics. The use of TORP labs and collaboration with surfactant providers adds technical depth.

- Reviewer: G-62-O1

- Rating: 3

The Devon Project Team has a wealth of knowledge and they may have something proprietary that they can't share. As such, the methodology outlined within the application was average. The lab testing of suitable surfactant compatibility and the bullhead injection has been around for decades. There wasn't anything noted in the application that would make this any different from testing I have seen or have been part of in the past.

- Reviewer: G-62-O2

- Rating: 3

The methodology uses a stepwise approach and extensive laboratory testing to increase the probability of success at the most expensive stage of field testing.

- Reviewer: G-62-O3

- 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:

The project addresses a critical gap in surfactant EOR application in unconventional reservoirs. If successful, it could unlock incremental recovery across hundreds of wells and inform best practices for broader deployment.

- Reviewer: G-62-O1

- Rating: 4

If surfactant EOR is successful, it could provide a lower cost and more immediate impact across thousands of Bakken/Three Forks wells. It could be deployed at a much faster rate than gas/CO2 recovery methods.

- Reviewer: G-62-O2

- Rating: 5

The scientific and technical information from this project could lead to large scale implementation of Bakken and Three Forks EOR. At a minimum the project will greatly improve future research projects. Project success will mean decades of additional oil and gas production in the state.

- Reviewer: G-62-O3

- Rating: 4

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 includes seasoned professionals with decades of experience in EOR, reservoir engineering, and field operations. The proposal references current surfactant technologies and includes collaboration with academic and industry experts.

- Reviewer: G-62-O1

- Rating: 4

Again, the Devon Team has a wealth of knowledge, but there wasn't any mention back to specific research or specific experience to other EOR projects managed.

- Reviewer: G-62-O2

- Rating: 3

Surfactant flooding has been practiced for decades and there is a great deal of information available in existing literature to inform this project. While it is unproven in unconventional reservoirs this project leverages existing knowledge through extensive laboratory testing to increase the probability of success.

- Reviewer: G-62-O3

- Rating: 3

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 plan includes milestone tracking, risk management, and stakeholder engagement. While the Gantt chart is pending, the structure and reporting commitments are solid and reflect good project governance.

- Reviewer: G-62-O1

- Rating: 2

Devon mentions in their application that a project schedule will be developed and wasn't included. Due to this reason and lack of well-defined milestone chart, I am putting it as adequate knowing the framework for the project is 24 months. I think a tentative schedule and milestone chart could have been included.

- Reviewer: G-62-O2

- Rating: 3

The applicant plans to use risk assessment, change management, and stakeholder engagement at each project stage to ensure the project stays on track.

- Reviewer: G-62-O3

- Rating: 2

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

The proposal outlines the use of existing Devon-operated wells and infrastructure. While no major equipment purchases are listed, the use of bullhead injection and surveillance tools is appropriate and justified.

- Reviewer: G-62-O1
- Rating: 3

There isn't any purchase of equipment needed. The facilities available on location should be adequate to handle the flowback of water.

- Reviewer: G-62-O2
- Rating: 5

No equipment purchases are planned and the laboratory facilities required should be readily available.

- Reviewer: G-62-O3
- Rating: 3

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

The \$3.37M budget is reasonable for the scope. Devon is requesting \$1.535M from NDIC, with the remainder covered by internal funding. The cost breakdown is clear and reflects good value for the expected technical outcomes.

- Reviewer: G-62-O1
- Rating: 3

The value associated with the budget is exceptionally good. The lab testing, diagnostics, and data collection is of exceptionally good value.

- Reviewer: G-62-O2
- Rating: 5

The availability of experienced field personnel and suitable well bores along with the decades of information available on surfactants and the University partner provide good budget value.

- Reviewer: G-62-O3
- Rating: 4

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

Devon is contributing more than 50% of the total project cost, meeting NDIC match requirements. This demonstrates strong internal commitment and reduces reliance on public funding.

- Reviewer: G-62-O1
- Rating: 3

I am putting this as average value due to the 50% match funding from Devon.

- Reviewer: G-62-O2
- Rating: 3

The financial position and operations of the applicant provide a very robust matching fund budget.

- Reviewer: G-62-O3
- Rating: 4

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

The Devon Energy proposal is a technically sound, well-scoped, and strategically aligned project that addresses a key opportunity for Enhanced Oil Recovery in North Dakota's unconventional reservoirs. Its strengths include: A clear and achievable plan. Strong technical methodology and partnerships. Experienced team with operational control. High potential for scalability and economic impact. The project is recommended for funding consideration, with particular value in its ability to inform broader surfactant EOR deployment strategies across the Williston Basin.

- Reviewer: G-62-O1

The technical team at Devon and their EOR experience is of great value for the proposed project. Testing surfactant based EOR has more upside than downside and it is a niche of the industry that is constantly evolving. What may not have worked 5 years ago can become a viable solution due to delivery methods, formula changes, or a better understanding of the reservoir to name a few. While I thought the application hit all the points, it would have been nice to have more detail about the proposed project itself. For example, a map view diagram of the wells and what the current thinking is for which wells would be tested with the surfactant, why, preliminary volume estimates of what a treatment would look like. It also would have helped to hear about any examples where Devon has tried the surfactant based EOR in their portfolio or referenced other industry examples. Any details that would have shown why Devon thinks this project could ultimately be successful.

- Reviewer: G-62-O2

The applicant has the scalability to improve the probability of success with this project. The partner TORP has knowledge and experience to increase the probability of success. The undetermined location of the proposed project creates some uncertainty.

- Reviewer: G-62-O3

PROJECT ABSTRACT

Devon Energy proposes a testing campaign followed by a field pilot to demonstrate the technical and economic viability of surfactant-based Enhanced Oil Recovery (EOR) in the Williston Basin, North Dakota. The project will study and select the appropriate surfactant and methodology, then proceed to inject a surfactant solution targeting the Middle Bakken and/or Three Forks formations on three wells. The objective is to increase oil recovery by mobilizing residual hydrocarbons, optimize operational parameters, and provide a scalable blueprint for broader EOR deployment in North Dakota. The pilot leverages Devon's infrastructure and technical expertise, with a strong focus on risk management, stakeholder engagement, and cost-sharing.

The initial laboratory work (Phase 1) will focus on understanding surfactant compatibility and survivability. Experiments and simulation will be conducted at the Tertiary Oil Recovery Program (TORP) labs of University of Kansas under the investigation of Dr. Reza Barati, Don W. Green Professor of Chemical and Petroleum Engineering, in cooperation with Premier Corex. Studies will focus on surfactant brine screening and product selection, emulsion and phase behavior tests, core parameters, K, Phi & Saturations and will culminate in a design to identify the best surfactant(s) performance in core plugs for piloting.

Phase 2 (pilot phase) will be executed at the Bull Moose/North John Elk DSU pad (or equivalent nearby pad based on ideal operability). These are multi-lateral developments targeting the Middle Bakken and Three Forks (four wells each). The test will focus on three horizontal injectors with volumes and surfactant concentrations to be determined.

DIRECTOR'S COMMENTS**G-062-H****Enhanced Oil Recovery and Advanced Completion Design for Tight Carbonate Reservoirs in Western North Dakota**

Submitted by: Cobra Oil & Gas Corporation

Principal Investigator: Kyle Gardner

Request for: \$5,000,000

Total Project Costs: \$10,000,000

Duration: 21 months

Description of the Project:

Cobra Oil & Gas Corporation (Cobra) is seeking funding from the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP) for a research project to evaluate enhanced oil recovery (EOR) and advanced completion methods to increase oil production from tight carbonate reservoirs such as the lower Interlake Formation of the Stoneview Field in western North Dakota. The goal of the project is to identify and implement methods to increase the recovery factor of tight carbonate reservoirs through reservoir characterization and numerical simulation of different completion, stimulation, and EOR scenarios. The Stoneview-Stonewall Unit (SSU), with existing vertical and horizontal wells, provides an opportunity for field validation of modeled EOR, completion, and stimulation strategies that can be replicated in other tight reservoirs across North Dakota, including the Bakken petroleum system (Bakken).

The expected results will be field-validated operational and completion strategies for optimizing oil production for the lower Interlake Formation case study. Although the work will focus on the project field operated by Cobra, the learnings from this project will establish baseline operational EOR and completion strategies for oil production from the many other tight reservoirs throughout the Williston Basin, including the Bakken.

Technical Reviewers' Recommendations: 1 Do Not Fund, 1 Fund, 1 Funding to be Considered

Director's Recommendation: Recommend funding in the amount of \$4,000,000

Conflicts of Interest: None

Council Motion: Fund in the amount of \$4,750,000 (5% less than the original request). In addition, funding for 100% of the total request contingent upon additional funding from the US Department of Energy.

Vote: 6 yes; 0 nay, absent and not voting

Technical Reviewers' Rating Summary

Proposal Number **G-62-H** Application Title **"Enhanced Oil Recovery** Submitted By
Cobra Oil & Gas Corporation Request For **\$5,000,000.00** Total Project Costs
\$10,000,000.00

Section A. Scoring

Statement	Weighting Factor	G-62-H1	G-62-H2	G-62-H3	Average Weighted Score
1. Objectives	9	3	4	4	27
2. Achievability	7	3	3	4	21
3. Methodology	8	2	4	5	24
4. Contribution	8	2	4	3	24
5. Awareness / Background	5	3	3	5	15
6. Project Management	3	3	4	4	9
7. Equipment / Facilities	2	3	3	3	6
8. Value / Industry - Budget	4	3	3	4	12
9. Financial Match - Budget	4	3	4	4	12
Average Weighted Score		134	182	203	173

Total: 50

250 possible points

OVERALL RECOMMENDATION

FUND

X

FUNDING TO BE CONSIDERED

X

DO NOT FUND

X

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 proposal clearly outlines its goal to develop EOR and completion strategies for tight carbonate reservoirs, with a strong focus on the Stoneview-Stonewall Unit and broader applicability to ND reservoirs.

- Reviewer: G-62-H1

- Rating: 3

The objectives of this proposal align well with the legislative intent in SB 2014

- Reviewer: G-62-H2

- Rating: 4

The objectives and goals are very clear on what the project is going to accomplish. Where there could have been more clarity is the implementation of lab testing to field testing. What would have helped is to provide more detail on how the lab testing would be implemented (or how it would change the base case approach), on which wells, and how. It is understandable the the lab testing will dictate which direction the project will move, but there should be a

base case given the anticipated costs shown in the table for field testing.

- Reviewer: G-62-H3

- Rating: 4

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

The scope, timeline, and budget are realistic. The partnership with EERC and Cobra's operational control of the SSU enhances feasibility.

- Reviewer: G-62-H1

- Rating: 3

The applicant has limited experience operating similar projects, but has detailed data on the previous EOR projects in the SSU.. The proposed timetable and budget are based on that information and EERC experience. They are realistic, but are not likely to deliver any results by the 2027 legislative assembly.

- Reviewer: G-62-H2

- Rating: 3

The timelines seem achievable. From my experience, lab testing, simulation, and numerical models always take longer than anticipated if an appropriate buffer is not built in.

- Reviewer: G-62-H3

- Rating: 4

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

The five-task structure is well-organized and technically sound. Use of lab testing, simulation, and field validation is appropriate.

- Reviewer: G-62-H1

- Rating: 2

The applicant is leveraging lessons learned from the previous SSU projects to design an improved project methodology that increases the probability of success.

- Reviewer: G-62-H2

- Rating: 4

The partnership with the EERC is great. The quality of the methodology and the resources available make this a great research heavy project.

- Reviewer: G-62-H3

- Rating: 5

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:

The project addresses underexplored tight carbonate reservoirs and could influence broader EOR strategies in ND but is not immediately adjacent to more meaningful reserves in ND.

- Reviewer: G-62-H1

- Rating: 2

The scientific and technical information from this project could lead to large scale implementation of tight conventional resource EOR. Project success will mean decades of additional oil and gas production in the state.

- Reviewer: G-62-H2

- Rating: 4

I agree that this could have a large impact to similar conventional reservoirs that display the same or nearly the same petrophysical and reservoir properties. I don't agree that this project

could be directly applied to the Bakken as stated, although I do think that the project could indirectly help future studies/projects similar to this for the Bakken by way of workflows, EOR methods, etc.

- Reviewer: G-62-H3

- 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:

Cobra's team has relevant experience, and EERC brings strong technical depth. The resumes support the team's capability.

- Reviewer: G-62-H1

- Rating: 3

The applicant has limited experience in the area of this research project, but can leverage data from previous SSU projects and EERC expertise to greatly increase the probability of success.

- Reviewer: G-62-H2

- Rating: 3

Cobra has partnered with the EERC, which would have vast knowledge of the current research and studies. There is no doubt they are aware of all the available published literature and current studies related to their proposed project.

- Reviewer: G-62-H3

- 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 management structure is functional, with EERC leading technical tasks and Cobra managing field operations.

- Reviewer: G-62-H1

- Rating: 3

The project plans are based on data from similar projects. Infrastructure has to be built and gas acquisition and marketing agreements have to be negotiated.

- Reviewer: G-62-H2

- Rating: 4

The project management plan is solid with the appropriate details. The only item I wished there was more detail and background on was the financial plan as it relates to the field testing and associated equipment.

- Reviewer: G-62-H3

- Rating: 4

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

Equipment needs are reasonable and aligned with project goals. The ICV system adds value.

- Reviewer: G-62-H1

- Rating: 3

This proposal is based on data from previous projects. The budget avoids NDIC purchase of gas for injection. I would like to see NDIC and applicant funds redistributed to reduce NDIC equipment/CAPEX purchases/ownership and increase NDIC share of equipment leases and OPEX.

- Reviewer: G-62-H2
- Rating: 3

I feel the details on the field testing were lacking. If there was a "base case" of current thinking that would have detailed where the purchase of equipment was coming from, that would have helped. Undoubtedly, equipment will have to be purchased to implement the field testing and it is justified, it could have been explained in more detail.

- Reviewer: G-62-H3
- Rating: 3

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

The \$10M budget is proportionate to the scope. Cobra’s 50% cost share strengthens the value proposition. Unclear on what the money will be used for.

- Reviewer: G-62-H1
- Rating: 3

The lessons learned from the previous projects and EERC expertise accelerate the project timeline and provide a sound budget.

- Reviewer: G-62-H2
- Rating: 3

The budget seems reasonable based on the scope and the commitment from the EERC as well as Cobra is why this is rated as Notably Good.

- Reviewer: G-62-H3
- Rating: 4

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

Cobra provides a full 50% match, meeting program guidelines.

- Reviewer: G-62-H1
- Rating: 3

The financial position of the applicant provides a sound matching fund budget. Funding should be contingent upon written commitment of cost share being provided by an existing EERC project with DOE, the details of which are in the final stages of negotiation and are unable to be explicitly shared at this time.

- Reviewer: G-62-H2
- Rating: 4

The contribution from Cobra and the assumed contribution from the Department of Energy, is what makes this a high value commitment.

- Reviewer: G-62-H3
- Rating: 4

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

This proposal is well-structured but targets a niche reservoir type. The integration of lab, modeling, and field testing is commendable. While not transformative basin-wide, it fills a critical knowledge gap and offers scalable insights.

- Reviewer: G-62-H1

The applicant has the information and EERC experience to greatly increase the probability of success with this project. The applicant should provide more information about why injectivity of this project is expected to be significantly better than the previous projects, what lessons were learned from previous projects, and how that increases the probability of success.

- Reviewer: G-62-H2

My view is that this is a very sound project that incorporates a high level of technical work prior to testing lab and model results in the field. This could have a meaningful impact across similar conventional reservoirs in North Dakota and extending the life of these type of conventional reservoirs should be pursued. They are an existing asset with a high degree of potential that could be extracted with successful outcomes of projects such as this one. The only flaw from the document was not outlining the field testing portion in more detail and establishing a base case of what is known today. There could have been more detail about the potential wells that would test (x) or (y), downhole equipment needed, what would alter that plan, etc.

- Reviewer: G-62-H3

Submit Summary

ABSTRACT

Objective: Cobra Oil & Gas Corporation (Cobra) is seeking funding from the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP) for a research project to evaluate enhanced oil recovery (EOR) and advanced completion methods to increase oil production from tight carbonate reservoirs such as the lower Interlake Formation of the Stoneview Field in western North Dakota. The goal of the project is to identify and implement methods to increase the recovery factor of tight carbonate reservoirs through reservoir characterization and numerical simulation of different completion, stimulation, and EOR scenarios. The Stoneview-Stonewall Unit (SSU), with existing vertical and horizontal wells, provides an opportunity for field validation of modeled EOR, completion, and stimulation strategies that can be replicated in other tight reservoirs across North Dakota, including the Bakken petroleum system (Bakken).

Expected Results: The expected results will be field-validated operational and completion strategies for optimizing oil production for the lower Interlake Formation case study. Although the work will focus on the project field operated by Cobra, the learnings from this project will establish baseline operational EOR and completion strategies for oil production from the many other tight reservoirs throughout the Williston Basin, including the Bakken.

Duration: The anticipated project duration is 21 months (October 1, 2025 – June 30, 2027).

Total Project Cost: The total project cost is \$10,000,000. Cobra is requesting \$5,000,000 from NDIC OGRP. Cobra is providing \$5,000,000 of cost share.

Participants: Cobra and the Energy & Environmental Research Center at the University of North Dakota.

DIRECTOR'S COMMENTS**G-062-M****Williston Basin Resources Optimization: Large-scale Miscible Gas Huff n Puff EOR Pilot in Continental's Dunn County Acreage – Roadrunner/Clover Pad**

Submitted by: Continental Resources

Principal Investigator: Jose Zaghoul, Ph D

Request for: \$8,771,905

Total Project Costs: \$26,889,228

Duration: 42 Months

Description of the Project:

The proposed project objective is to pilot Enhanced Oil Recovery (EOR) in the Bakken and Three Forks formations of the Williston Basin. Its primary goal is to evaluate the potential of Intermittent Gas Injection (IGI), also known as miscible gas Huff n Puff, to enhance oil recovery post-primary development. This technique has the potential to unlock vast remaining resources in the Bakken and Three Forks formations after primary development.

The large-scale pilot proposed herein involves evaluation of intermittent miscible gas injection in four wells: Clover 4-10H, Clover 5-10H, Roadrunner 6-15H, and Roadrunner 7-15H, all located in Dunn County. The project includes the design, construction, and operation of the facilities necessary to assess the incremental oil recoveries for the selected wells. Field and experimental evaluation goals include assessing gas injectivity, containment, injection conformance, efficiency of the miscible gas injection process, uplift, and potential scalability of the outcome. Gas cycling optimization will be a key part of this project. Novel technologies for improving gas injection conformance, such as gas-foam cycling, may also be implemented as determined by Continental, if feasible and necessary.

Preliminary integrated modeling results suggest an expected incremental oil recovery of ~100,000 barrels of oil per well for a pilot spanning 3 Huff n Puff cycles (~ 20% uplift). The three Huff n Puff cycles are expected to last approximately two years and may yield a total incremental oil recovery of ~ 400,000 barrels between all four wells. The pilot may be extended beyond this timeline if economically viable.

Technical Reviewers' Recommendations: 2 Fund, 1 Funding to be Considered**Director's Recommendation:** Recommend funding in the amount of \$8,333,905**Conflicts of Interest:** None

Council Motion: Fund in the amount of \$8,333,905 (5% less than the original request). In addition, funding for 100% of the total request contingent upon additional funding from the US Department of Energy.

Vote: 6 yes; 0 nay, absent and not voting

Technical Reviewers' Rating Summary

Proposal Number	G-62-M	Application Title	"Williston Basin Resou	Submitted By
Continental Resources	Request For	\$8,771,905.00	Total Project Costs	
\$26,889,228.00				

Section A. Scoring

Statement	Weighting Factor	G-62-M1	G-62-M2	G-62-M3	Average Weighted Score
1. Objectives	9	5	5	4	36
2. Achievability	7	5	5	3	28
3. Methodology	8	5	5	4	32
4. Contribution	8	5	5	4	32
5. Awareness / Background	5	5	5	5	25
6. Project Management	3	4	4	4	12
7. Equipment / Facilities	2	4	5	3	8
8. Value / Industry - Budget	4	4	5	4	16
9. Financial Match - Budget	4	5	4	5	16
Average Weighted Score		241	243	200	228

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 proposal articulates its goals with precision, aligning directly with NDIC's strategic objectives.

- Reviewer: G-62-M1
- Rating: 5

CLR has provided great detail around the objectives of what they hope to achieve and potentially improve during the proposed project timeline. There was great detail on the huff n puff project itself.

- Reviewer: G-62-M2
- Rating: 5

The objectives of this proposal align very well with the legislative intent in SB 2014

- Reviewer: G-62-M3
- Rating: 4

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

Continental's operational scale, infrastructure access, and technical planning make this project highly feasible.

- Reviewer: G-62-M1

- Rating: 5

The objectives are certainly achievable. CLR has initiated a lot of the upfront work needed for model building, screening, equipment procurement, gas sourcing, and apply lessons learned from a previous EOR project in the basin. The knowledge gained from the prior project will be invaluable to correcting the critical variables to make this project meet the objectives as put forth in the application.

- Reviewer: G-62-M2

- Rating: 5

The applicant has extensive experience operating similar projects. The proposed timetable and budget are based on that experience. They are realistic and will not deliver any results until months after the 2027 legislative assembly.

- Reviewer: G-62-M3

- Rating: 3

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

The two-stage approach, use of ResFrac modeling, tracer studies, and foam cycling demonstrate advanced methodology.

- Reviewer: G-62-M1

- Rating: 5

The methodology displayed in the application is on point, thought out, has technical backing, and has the benefit of a prior project in the basin to which valuable insight has been gained.

- Reviewer: G-62-M2

- Rating: 5

The applicant is leveraging lessons learned from previous projects to design an improved project methodology that increases the probability of success.

- Reviewer: G-62-M3

- Rating: 4

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:

This pilot could unlock 3–8 billion barrels of oil and transform EOR deployment in the Williston Basin.

- Reviewer: G-62-M1

- Rating: 5

A successful EOR project in the Bakken/Three Forks has billion barrel implications. This will extend the life of the existing wells and shuttle forward the enhanced oil recovery phase after drilling inventory dwindles in the coming years.

- Reviewer: G-62-M2

- Rating: 5

The scientific and technical information from this project will lead to large scale implementation of Bakken and Three Forks EOR or at a minimum greatly improved future research projects. Project success will mean decades of additional oil and gas production in

the state.

- Reviewer: G-62-M3

- Rating: 4

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 includes industry leaders with deep EOR experience. Continental's track record in Anadarko and Williston pilots is impressive.

- Reviewer: G-62-M1

- Rating: 5

Multiple EOR projects were referenced in the application, which included CLR's EOR projects benchmarked against others in industry. CLR has performed a previous EOR project in the Bakken, learned from it, and will now apply that knowledge to a newly designed EOR project.

- Reviewer: G-62-M2

- Rating: 5

The applicant has extensive experience in the area of this research project and can leverage lessons learned from its nearby project to greatly increase the probability of success.

- Reviewer: G-62-M3

- 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 plan includes detailed timelines, safety protocols, and monitoring systems. Weekly and quarterly reporting is a strength.

- Reviewer: G-62-M1

- Rating: 4

The detail provided within the application is well thought out and is very complete.

- Reviewer: G-62-M2

- Rating: 4

The project plans are based on recent experience with similar projects. Extensive infrastructure has to be built and gas acquisition and marketing agreements have to be negotiated.

- Reviewer: G-62-M3

- Rating: 4

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

The proposal provides detailed cost breakdowns and technical rationale for each equipment item.

- Reviewer: G-62-M1

- Rating: 4

The detail and justification provided for each of the equipment purchases and/or facility upgrades was exactly what was needed. The "Project Detailed Scope of Work" section was greatly appreciated and was very thought out and detailed.

- Reviewer: G-62-M2

- Rating: 5

This proposal is based on a recent project. The budget avoids NDIC purchase of gas for injection. I would like to see NDIC and applicant funds redistributed to reduce NDIC equipment/CAPEX purchases/ownership and increase NDIC share of equipment leases and OPEX.

- Reviewer: G-62-M3

- Rating: 3

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

The \$26.9M budget is large but justified by scale and expected outcomes. Continental’s in-kind contributions are substantial.

- Reviewer: G-62-M1

- Rating: 4

The budget value is exceptionally good for a project with such enormous upside if it could be applied to a substantial amount of existing Bakken and Three Forks wells. CLR also received many letters of support from an industry partner (Oxy) as well as state legislatures and the former Director of Mineral Resources.

- Reviewer: G-62-M2

- Rating: 5

The availability of equipment and lessons learned from the previous project accelerate the project timeline and provide a very robust budget.

- Reviewer: G-62-M3

- Rating: 4

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

Continental provides over 67% of the total cost, exceeding match requirements.

- Reviewer: G-62-M1

- Rating: 5

CLR is providing a high value of financial commitment of ~2/3 of the project vs the requested amount of 1/3rd from the NDIC-OGRP.

- Reviewer: G-62-M2

- Rating: 4

The experience and availability of equipment from the previous project along with the financial position of the applicant provide a very robust matching fund budget.

- Reviewer: G-62-M3

- Rating: 5

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

This is a flagship EOR pilot with basin-wide implications. The technical rigor, economic potential, and strategic alignment with NDIC goals make it a top-tier proposal. Strong industry support and infrastructure readiness further enhance its merit.

- Reviewer: G-62-M1

Continental's project is very well thought out. The technical screening to identify the proper wells/pads for the highest chance of success, the implementation of previous knowledge from a past huff n puff, and the reservoir characterization and modeling already underway shows a very high likelihood to meet the objectives put forth in the application. There are concerns about semi-bounded wells in the project and how that may impact offsetting DSUs in terms of pressure responses from gas breakthrough and production accounting. Additional details surrounding how/why 1,100 BTU/MSCF gas was selected vs other hydrocarbon sources (ethane, propane, field gas, etc.) would have been helpful. Any lab tests, miscibility tests, etc. for additional candidates could prove useful, understanding that there is constraints as it relates to availability and economics.

- Reviewer: G-62-M2

The applicant has the knowledge, experience, and scalability to greatly increase the probability of success with this project. The location of the proposed project allows relatively new reservoir to be tested and there is gas gathering and processing infrastructure in the area. The applicant should provide more information about how this project differs from the previous project, what lessons were learned from previous projects, and how that increases the probability of success.

- Reviewer: G-62-M3

Submit Summary

1. ABSTRACT

Objective:

The proposed project objective is to pilot Enhanced Oil Recovery (EOR) in the Bakken and Three Forks formations of the Williston Basin. Its primary goal is to evaluate the potential of Intermittent Gas Injection (IGI), also known as miscible gas Huff n Puff, to enhance oil recovery post-primary development.

Miscible Gas Huff n Puff EOR, proven effective in low permeability conventional reservoirs, is in a stage that still requires further research and development for consistent and successful application in unconventional reservoirs. Huff n Puff EOR involves injecting sufficient miscible gas to increase pressure and dissolve gas in the stimulated reservoir areas surrounding completed wells. The injected gas swells the contacted oil, reduces its viscosity, enhances near-fracture permeability, and significantly improves reservoir deliverability. This technique has the potential to unlock vast remaining resources in the Bakken and Three Forks formations after primary development.

The large-scale pilot proposed herein involves evaluation of intermittent miscible gas injection in four wells: Clover 4-10H, Clover 5-10H, Roadrunner 6-15H, and Roadrunner 7-15H, all located in Dunn County. The project includes the design, construction, and operation of the facilities necessary to assess the incremental oil recoveries for the selected wells. Field and experimental evaluation goals include assessing gas injectivity, containment, injection conformance, efficiency of the miscible gas injection process, uplift, and potential scalability of the outcome. Gas cycling optimization will be a key part of this project. Novel technologies for improving gas injection conformance, such as gas-foam cycling, may also be implemented as determined by Continental, if feasible and necessary.

Expected Results:

Preliminary integrated modeling results suggest an expected incremental oil recovery of ~100,000 barrels of oil per well for a pilot spanning 3 Huff n Puff cycles (~ 20% uplift). The three Huff n Puff cycles are expected to last approximately two years and may yield a total incremental oil recovery of ~ 400,000 barrels between all four wells. The pilot may be extended beyond this timeline if economically viable.

Duration:

We expect to pilot at least three Huff n Puff cycles over a period of up to two years of operation. The project is planned to start March 2026, and it is expected to be executed and operated over a span of 42 months. Project first gas injection is anticipated in 1Q 2027. A large-scale EOR pilot project, as proposed herein, typically requires 3 to 5 years for completion depending on its level of success.

Total Project cost:

The pilot's total estimated cost is \$26.89 million.

Participants:

Continental Resources will be the sole operator participating in this project.

Bakken Resource Development Optimization: A Multi Well, Multi Zone Enhanced Oil Recovery Project Utilizing Produced Natural Gas in Williams County – Durant Pad

Submitted by: Continental Resources

Principal Investigator: Dave Ratcliff

Request for: \$9,836,905

Total Project Costs: \$29,918,810

Duration: 2-4 Years

Description of the Project:

The pilot's primary objective is to evaluate the potential of Intermittent Gas Injection ("Huff n Puff") Enhanced Oil Recovery (EOR) to unlock the vast resource remaining in the Bakken and Three Forks formation after primary development.

Miscible Gas Huff n Puff EOR, proven effective in low permeability conventional reservoirs, is in a stage that still requires further research and development for consistent and successful application in unconventional reservoirs. Huff n Puff EOR involves injecting sufficient miscible gas to increase pressure and dissolve gas in the stimulated reservoir areas. The injected gas swells the contacted oil, reduces its viscosity, enhances near-fracture permeability, and significantly improves reservoir deliverability. This technique has the potential to unlock vast remaining resources in the Bakken and Three Forks formations after primary development.

This multi well, multi bench pilot proposed herein involves evaluation of intermittent miscible gas injection in up to four wells all located on the Durant Pad of Continental's Williston North acreage in Williams County. The project includes the design, construction, and operation of the facilities necessary to assess the incremental oil recoveries for the selected wells. Field and experimental evaluation goals include assessing gas injectivity, containment, injection conformance, efficiency of the miscible gas injection process, uplift, and potential scalability of the outcome. Gas cycling optimization and understanding the issues involved with scalability will be a key part of this project. Novel technologies for improving gas injection conformance, such as gas-foam cycling, may also be implemented as determined by Continental, if feasible and necessary.

Technical Reviewers' Recommendations: 1 Fund, 2 Funding to be Considered

Director's Recommendation: Recommend funding in the amount of \$13,298,290

Conflicts of Interest: None

Council Motion: Fund in the amount of \$4,750,000 (5% less than the original request). In addition, funding for 100% of the total request contingent upon additional funding from the US Department of Energy.

Vote: 6 yes; 0 nay, absent and not voting

Technical Reviewers' Rating Summary

Proposal Number	G-62-N	Application Title	Bakken Resources Developr	Submitted By
Continental Resources	Request For	\$9,836,905.00	Total Project Costs	
\$29,918,810.00				

Section A. Scoring

Statement	Weighting Factor	G-62-N1	G-62-N2	G-62-N3	Average Weighted Score
1. Objectives	9	5	5	4	36
2. Achievability	7	4	5	4	28
3. Methodology	8	5	5	5	40
4. Contribution	8	5	5	5	40
5. Awareness / Background	5	5	4	5	20
6. Project Management	3	5	5	5	15
7. Equipment / Facilities	2	5	5	4	8
8. Value / Industry - Budget	4	5	5	5	20
9. Financial Match - Budget	4	5	4	5	16
Average Weighted Score		243	241	232	238
Total: 50					250 possible points

OVERALL RECOMMENDATION

FUND	X	X	X
FUNDING TO BE CONSIDERED			
DO NOT FUND			

Section B. Ratings and Comments

- 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 proposal clearly outlines the goal of evaluating cyclic miscible gas injection (Huff n Puff) to enhance oil recovery in the Bakken and Three Forks formations. It aligns directly with NDIC/OGRC goals of increasing recovery efficiency, extending field life, and supporting carbon-neutral initiatives.

- Reviewer: G-62-N1
- Rating: 5

The objectives of this project are exceptionally clear. The expected result of the project (100,000 barrels of incremental oil per well) is very helpful to assess the overarching benefit to industry and North Dakota.

- Reviewer: G-62-N2
- Rating: 5

The objectives of this proposal align almost perfectly with the legislative intent in SB 2014

- Reviewer: G-62-N3

- Rating: 4

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

The approach is technically sound and supported by prior pilot experience. The timeline (42 months) and budget (~\$29.9M) are realistic for the scope. The phased implementation and use of advanced modeling (ResFrac) increase confidence in achieving the objectives.

- Reviewer: G-62-N1

- Rating: 4

The timelines are certainly achievable as Continental has put forth in the application. The extended huff n puff timeline is of considerable importance to get a solid understanding of the incremental production through each of the 3 huff n puff cycles.

- Reviewer: G-62-N2

- Rating: 5

The applicant has extensive experience operating similar projects one of which was nearby. The proposed timetable and budget are based on that experience. They are realistic and will deliver some early results during the 2027 legislative assembly.

- Reviewer: G-62-N3

- Rating: 4

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

The methodology includes detailed reservoir modeling, tracer studies, pressure interference testing, and potential gas-foam cycling. The use of modern completions and infrastructure optimization reflects a high level of technical planning.

- Reviewer: G-62-N1

- Rating: 5

The methodology put forth in the application is on point. Everything from the screening criteria, the previous EOR project, implementation of the knowledge from the previous project, modelling, the detailed scope of work, to the uplift expectation all points to a well thought out plan and methodology.

- Reviewer: G-62-N2

- Rating: 5

The applicant is leveraging lessons learned from previous projects to design an improved project methodology that increases the probability of success.

- Reviewer: G-62-N3

- Rating: 5

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:

The project could unlock 100,000 barrels of incremental oil per well and inform broader EOR deployment across 770+ locations in Williams County. It supports ND's goals of maximizing resource recovery and reducing environmental impact.

- Reviewer: G-62-N1

- Rating: 5

A successful outcome of this project has the potential to add billions of barrels of additional production. The significance of EOR projects can't be overstated. The types of projects that Continental is putting forth in the application is needed as the unconventional reservoirs start to shift from primary development to enhanced recovery as inventory becomes more scarce through the years. Gaining an understanding earlier rather than later can help to improve EOR

in unconventional reservoirs before inventory is exhausted.

- Reviewer: G-62-N2

- Rating: 5

The scientific and technical information from this project will lead to large scale implementation of Bakken and Three Forks EOR or at a minimum greatly improved future research projects. Project success will mean decades of additional oil and gas production in the state.

- Reviewer: G-62-N3

- Rating: 5

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 includes industry veterans with over 140 years of combined experience. The proposal references prior pilots, published modeling techniques, and collaborative workshops with other operators (e.g., Occidental), demonstrating strong awareness of current research.

- Reviewer: G-62-N1

- Rating: 5

Continental has experience with EOR (in the Bakken as well as other basins) and they are benchmarking themselves against their peers. The knowledge gained from the past Bakken EOR lends itself to designing another EOR project that accounts for the lessons learned.

- Reviewer: G-62-N2

- Rating: 4

The applicant has extensive experience in the area of this research project and can leverage lessons learned from its nearby project to greatly increase the probability of success.

- Reviewer: G-62-N3

- 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 proposal includes a detailed timeline, milestone chart, and operational plan. It outlines safety protocols, SCADA monitoring, and communication strategies among field teams and engineering staff.

- Reviewer: G-62-N1

- Rating: 5

Everything is put forth in a detailed way that is easy to understand and follow.

- Reviewer: G-62-N2

- Rating: 5

The project plans are based on recent experience with similar projects and include using some existing infrastructure from a nearby project.

- Reviewer: G-62-N3

- Rating: 5

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

Equipment purchases and leases (compressors, separators, line heaters) are clearly tied to project needs. Facility upgrades are necessary for high-pressure injection and increased gas production during puff cycles.

- Reviewer: G-62-N1
- Rating: 5

Continental was very detailed and thorough in the explanation for equipment, well work, and facilities. All of this is justified with this type of EOR project.

- Reviewer: G-62-N2
- Rating: 5

This proposal is based on a recent nearby project. The budget avoids NDIC purchase of gas for injection. I would like to see NDIC and applicant funds redistributed to reduce NDIC equipment/CAPEX purchases /ownership and increase NDIC share of equipment leases and OPEX.

- Reviewer: G-62-N3
- Rating: 4

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

Continental is contributing ~\$9.3M in-kind (gas purchase) and additional cash, covering nearly two-thirds of the total cost. The budget is well-structured and reflects high value for the technical outcomes expected.

- Reviewer: G-62-N1
- Rating: 5

This project shows exceptionally good value. Field implementation of modeling or lab testing is needed in order to assess and modify for continued technical and economic improvement.

- Reviewer: G-62-N2
- Rating: 5

The availability of equipment and lessons learned from the previous nearby project accelerate the project timeline and provide a very robust budget outline.

- Reviewer: G-62-N3
- Rating: 5

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

The proposal meets and exceeds the 50% match requirement. Continental’s in-kind and cash contributions, along with DOE support, demonstrate strong industry commitment and reduce reliance on NDIC funding.

- Reviewer: G-62-N1
- Rating: 5

Continental is contributing ~2/3rd of the financial commitment, while they are asking for ~1/3rd commitment from the NDIC-OGRP.

- Reviewer: G-62-N2
- Rating: 4

The availability of equipment from the previous nearby project and the financial position of the applicant provide a very robust matching fund budget.

- Reviewer: G-62-N3
- Rating: 5

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

The G-62-N proposal is a highly compelling and well-developed application for Enhanced Oil Recovery research. It demonstrates: Strong alignment with NDIC/OGRC goals. Technical excellence in methodology and modeling. Robust project management and operational planning. Exceptional team qualifications and industry collaboration. High financial commitment from Continental and other sources. The proposal addresses key challenges in unconventional reservoir recovery and offers scalable solutions with significant economic and environmental benefits for North Dakota. It is recommended for full funding consideration.

- Reviewer: G-62-N1

Continental has put forth a very detailed and thought out approach to their project that is backed by technical rigor, previous Bakken EOR experience, and a strong plan to achieve the objectives set forth in the application. Again, these projects are crucial to the next phase of unconventional oil and gas production. More explanation surrounding the sourced gas (1,100 btu/mscf) and why it was chosen, would have been helpful as well as any miscibility testing done with other EOR substances (ethane, propane, CO₂, etc.) and the results. All in all, a very solid project underpinned by a high degree of technical application.

- Reviewer: G-62-N2

The applicant has the knowledge, experience, and scalability to greatly increase the probability of success with this project. The location of the proposed project allows the use of existing infrastructure and equipment. The applicant should provide more information about how this project differs from the previous nearby project, what lessons were learned from previous projects, and how that increases the probability of success.

- Reviewer: G-62-N3

1: ABSTRACT

Objective:

The pilot's primary objective is to evaluate the potential of Intermittent Gas Injection ("Huff n Puff") Enhanced Oil Recovery (EOR) to unlock the vast resource remaining in the Bakken and Three Forks formation after primary development.

Miscible Gas Huff n Puff EOR, proven effective in low permeability conventional reservoirs, is in a stage that still requires further research and development for consistent and successful application in unconventional reservoirs. Huff n Puff EOR involves injecting sufficient miscible gas to increase pressure and dissolve gas in the stimulated reservoir areas. The injected gas swells the contacted oil, reduces its viscosity, enhances near-fracture permeability, and significantly improves reservoir deliverability. This technique has the potential to unlock vast remaining resources in the Bakken and Three Forks formations after primary development.

This multi well, multi bench pilot proposed herein involves evaluation of intermittent miscible gas injection in up to four wells all located on the Durant Pad of Continental's Williston North acreage in Williams County. The project includes the design, construction, and operation of the facilities necessary to assess the incremental oil recoveries for the selected wells. Field and experimental evaluation goals include assessing gas injectivity, containment, injection conformance, efficiency of the miscible gas injection process, uplift, and potential scalability of the outcome. Gas cycling optimization and understanding the issues involved with scalability will be a key part of this project. Novel technologies for improving gas injection conformance, such as gas-foam cycling, may also be implemented as determined by Continental, if feasible and necessary.

Expected Results:

The expected modelled uplift over the 'baseline' production (e.g. production we would expect if nothing had been done) after three cycles of Huff n Puff will be ~20% increase, resulting in an incremental oil recovery of ~100,000 barrels of oil per well.

Duration:

We anticipate piloting at least three cycles which may last up to two years after injection begins. The overall duration of the project will be subject to the economic viability of subsequent cycles. The pilot duration may be extended if results prove to be successful.

Total Project Cost:

The project is expected to cost \$29.92 million.

Participants:

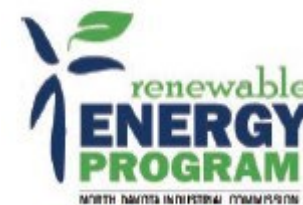
Continental Resources will be the sole operator.



RENEWABLE ENERGY PROGRAM PROJECT MANAGEMENT REPORT

Jordan Kannianen, Deputy Executive Director, NDIC

October 2025



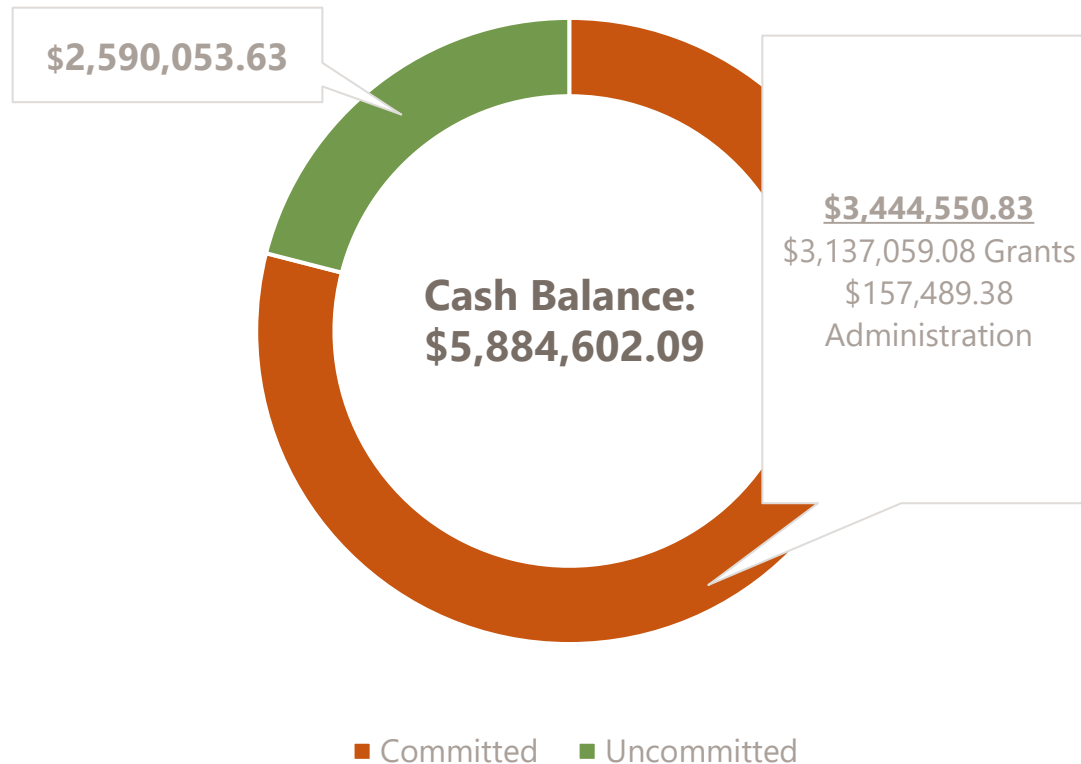
NORTH
Dakota

Be Legendary.™

RENEWABLE ENERGY FUND BALANCE

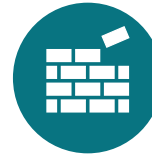
OCTOBER 2025

Renewable Energy Fund



Funding Source:

- \$3 million oil production taxes



76 Cumulative Projects



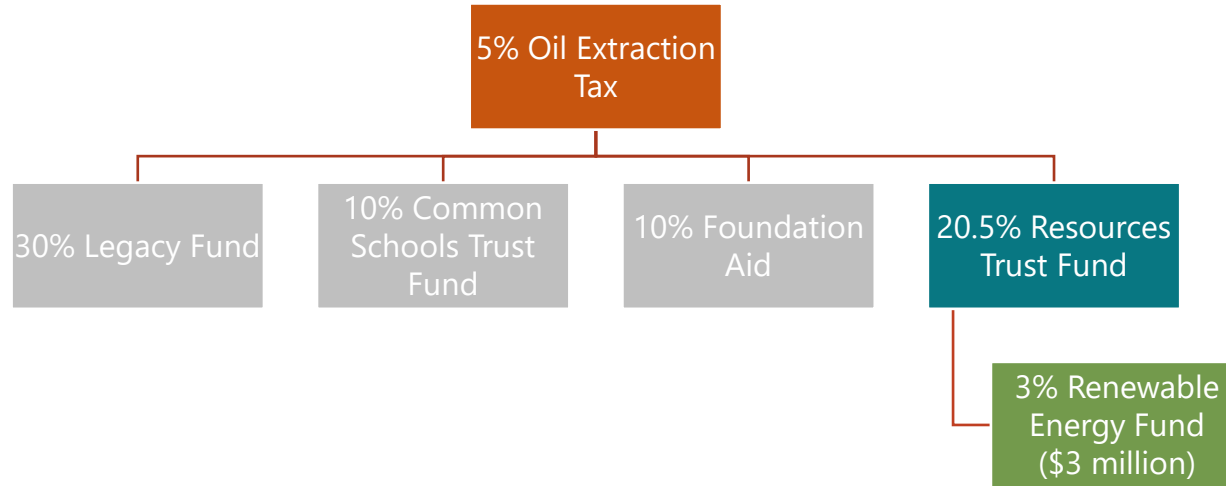
13 Active Projects



Cumulative Value:

- \$26.6 million granted
- \$168.9 million project value

2025-2027 BIENNIUM APPROPRIATION AND FORECASTED INCOME



Assumes:



\$59 & \$57/barrel



1.15m & 1.1 m bbls/day

Month	OMB Forecast	Actual
August 2025	\$454,315	\$484,440.83
September 2025	\$469,459	\$
October 2025	\$469,459	\$
November 2025	\$454,315	\$
December 2025	\$469,459	\$
January 2026	\$454,315	\$

**Renewable Energy Program
Grant Round 56
Application Summary Page
R-056-A**

Project Title: Unlocking Lithium Carbonate in Produced Water for Battery Grade Li_2CO_3 for In-State Cathode Manufacturing

Applicant: Triple 8, LLC Dba Wellspring Hydro

Primary Contact: Mat Hirst

Total Project Costs: \$1,000,000

REP Request: \$500,000

Summary of Project: Build on the renewable component of a sustainable lithium extraction process utilizing DLE and now the refining step, creating bulk Li_2CO_3 from the field to provide technically validated 99.5% lithium carbonate samples.

Technical Reviewer Comments: (Overall Score 165.33 out of 250)

- I am fascinated by this proposal and believe it would be an awesome project in the state of North Dakota. There is a ready market in the state that would like this project to be completed (including the University of North Dakota). I do believe this is a worthy investment for the state of North Dakota but, the NDIC Renewable Energy Council is not the place to provide the funding, as this project fails to meet any of the goals and purposes set forth in the REC's mission statement. Therefore, I cannot recommend funding this proposal.
- I suggest funding should be considered. I like what I see as the goal of this activity, establishing a commercially viable supply chain in ND for Li in battery technology. I would have been a stronger supporter of this effort if additional information had been provided, namely the report of the successful test in June and July of this year. Including more information on the proprietary technology to be used.
- Overall, this is a very good project for the State of ND and the country as a whole. As stated above, the value of using a waste stream to produce a needed commodity in North Dakota is very high. This project has the potential to develop into a large industry that is anchored in the state.

REP Advisory Board Recommendation: Fund

WELLSPRING HYDRO RENEWABLE ENERGY PROGRAM

OCTOBER 21, 2025



WELLSPRING HYDRO LITHIUM



*Utilize produced water waste stream to create valuable industrial products with regional demand to support a circular business model. **More than 1.5 Million Barrels of Water per day disposed in North Dakota.***

NORTH AMERICA LITHIUM PRODUCTION

Significant opportunity for North America lithium production to meet growing demand with potential for >10,000 tons per year LCE

PRODUCED WATER WASTE

Untapped produced water waste stream offers significant opportunity for creating products and extracting minerals.

BUSINESS MODEL OPTIONALITY

Opportunity to invest in multiple business model's that target different products at different scales and vertical integrations.

SUSTAINABLE DIRECT LITHIUM EXTRACTION (DLE)

Utilize existing infrastructure and efficient design to sustainably extract lithium with a **>450,000-gallon** reduction in water per tLCE versus traditional solution mining.

LITHIUM OPPORTUNITY

STRATEGICALLY POSITIONED - Significant opportunity for North America lithium production in two largest oil-producing basins (Permian and Bakken) to meet growing demand.

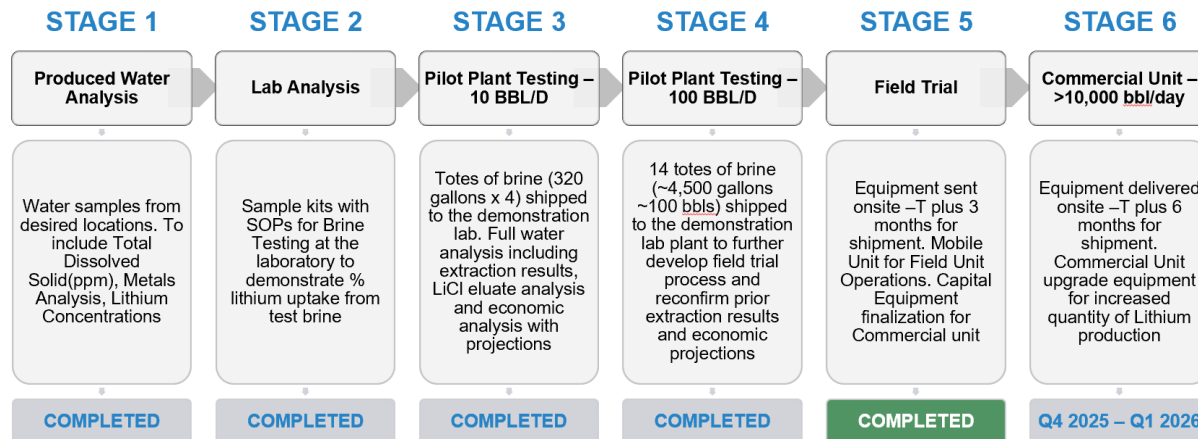
BAKKEN POTENTIAL - Up to **50,000 tonnes** of LCE annually with more than 1.5 million barrels produced per day. Nearly **3x higher lithium concentration** compared to the Permian.

SUPPLY LITHIUM FOR US DEMAND - Building active inventory of lithium chloride and converting to high-purity lithium carbonate for potential off-takers.

MODULAR APPROACH FOR RAPID GROWTH - Deployed and scaled North America's largest operational DLE system (10,000+ barrels/day) within six months of initial deployment.

PROVEN RESULTS WITH PROPRIETARY DLE - Proven results using our proprietary direct lithium extraction (DLE) technology to extract lithium from oilfield brine taken from multiple basins across North America.

SUSTAINABLE USE FOR PRODUCED WATER - Utilize existing infrastructure and efficient design to sustainably extract lithium with a **>450,000-gallon** reduction in water per tLCE versus traditional solution mining.



North Dakota Lithium Field Trial Pad Layout

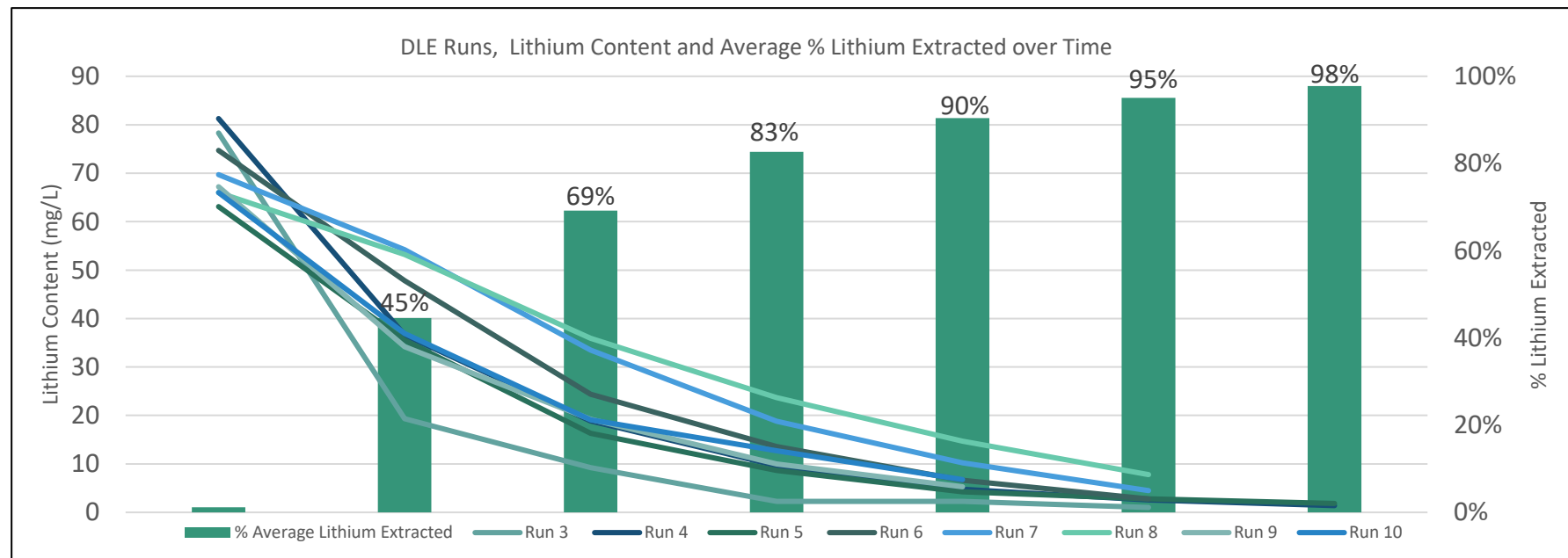
LITHIUM PAD



ND FIELD TRIAL OUTCOME

With the support from the Renewable Energy Program, the North Dakota field trial was conducted over June and July 2025 to validate lithium extraction performance of the ix media under real-world operating conditions.

- The trial successfully met all expectations, consistently achieving greater than 95% lithium extraction across all DLE runs using Raw Bakken formation water.
- Results confirmed the technical viability and reliability of the process at field scale, marking a critical milestone on the path toward commercial deployment.
- Based on the optimized field DLE runs, Wellspring Hydro and LibertyStream were able to extract between 90-99% of the lithium within 15 – 75 minutes.



With the success of the field trial, Wellspring Hydro/LibertyStream are ready to move to a commercial facility.

North Dakota WSH/LSI Execution

Demonstration Plant Testing



Shipping
4 totes of
Bakken water
to
Calgary

Demonstration Plant Operations

Successful
Extraction of 99%
of Lithium from
Brine



Shipping 14
tote of Bakken
Water to
Calgary

WSH began to
work with
LibertyStream
Infrastructure
Partners (formerly
Volt Lithium) in
2023

Dec. 2023

Testing Results
produced in April
2024 proving 99%
Li extraction

Apr. 2024

Onsite Trial
complete Avg 96%
Li extracted 99% Li
extraction
achieved

July 2025

Mar. 2024

Wellspring Hydro first sent
water to LSI in Q1 2024 to
confirm removal of Lithium

- Minimal pretreatment
- Ability to remove Li from low concentrations >100 mg/L
- Modular and Scalable

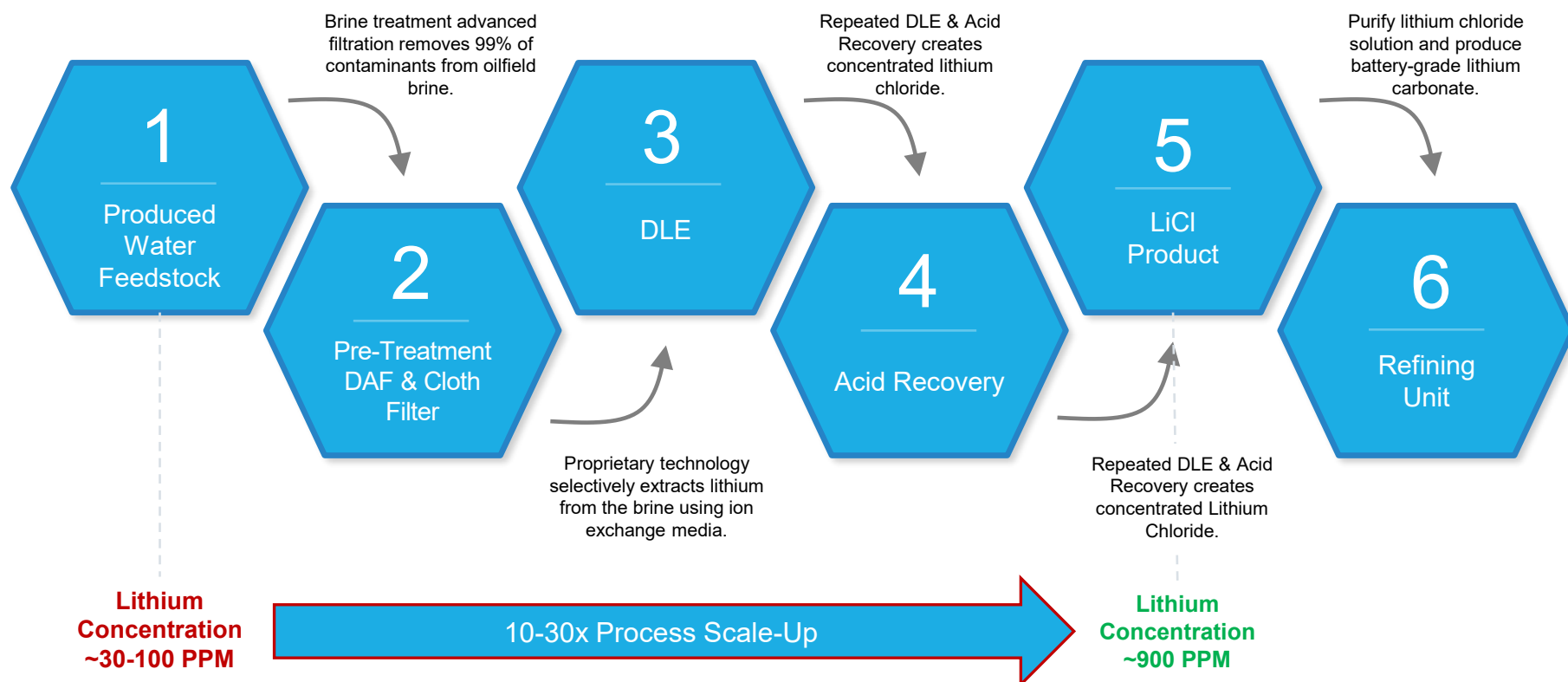
Nov. 2024

100bbls of water
shipped for further
testing. Again
confirming 99%
removal

Nov. 2025

Onsite Li refining
to 99.5% Li_2CO_3

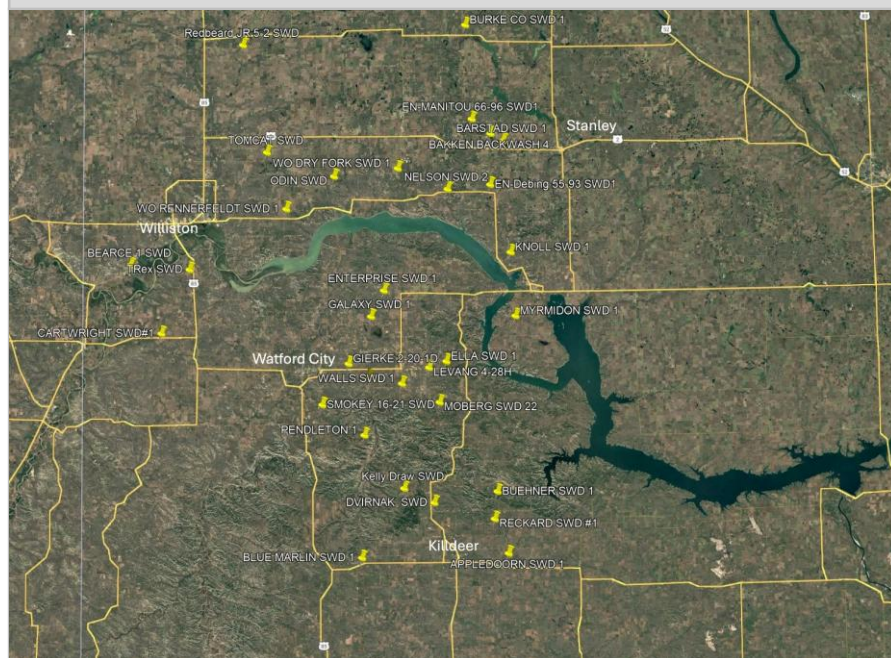
Next Generation Lithium Extraction



ND CRITICAL PATH FORWARD

Site Specific Lithium Qualification

Content, Pre-Treatment, and Defined Process



Lithium Refining Validation

Onsite Development, 3rd party Testing, and Equipment.

Parameter	Typical Battery-Grade Spec	Notes
Purity (Li_2CO_3)	≥ 99.5 wt % (some customers require ≥ 99.8 %)	Industrial grade is typically 98–99 %
Lithium content	~18.8 % Li	Pure stoich. value = 18.8 % Li
Moisture (H_2O)	≤ 0.3 wt %	Dry to prevent hydrolysis
Chloride (Cl^-)	≤ 50 ppm	Higher Cl causes corrosion
Sulphate (SO_4^{2-})	≤ 200 ppm	Affects electrolyte stability
Iron (Fe)	≤ 10 ppm	Metallic contamination risk
Sodium (Na)	≤ 200 ppm	Impacts cathode crystallinity
Calcium (Ca)	≤ 50 ppm	Affects conductivity and sintering
Magnesium (Mg)	≤ 50 ppm	Reduces electrode performance
Potassium (K)	≤ 50 ppm	Similar to Na — must be minimized
Heavy metals (Cu, Zn, Mn, Ni)	≤ 5 –10 ppm each	Degrades cycle life

Lithium qualification and refining validation prove the capability to meet the required quality and quantity of Lithium Carbonate to create a full life-cycle lithium ecosystem inside North Dakota from lithium extraction to battery manufacturing.

RENEWABLE SUBMISSION SCOPE

Wellspring Hydro requests the financial support of the Renewable Energy Program to complete the next step of commercialization including site specific lithium extraction qualification and associated high value 3rd party testing.

Site Specific Lithium Qualification	Lithium Refining Validation
Content, Pre-Treatment, and Defined Process	Onsite Development, 3 rd party Testing, and Equipment.
- Database to qualify sites based on the water content, TENORM, and pretreatment plans for >10 approved sites. - Each site will have a database of qualified water samples (validated from multiple vendors) and a defined plan for pre-treatment and the process.	- Meet Packet Digital's Lithium Carbonate specification, including through bulk samples prior to cell tests in 2026. Includes support from North Dakota universities based on the working relationship with UND and NDSU. - Receive a 3rd party validation report from a cathode manufacturer to support the successful production of high-grade Lithium Carbonate.
\$290,000 USD	\$710,000 USD

Lithium qualification and refining validation prove the capability to meet the required quality and quantity of Lithium Carbonate to create a full life-cycle lithium ecosystem inside North Dakota from lithium extraction to battery manufacturing.

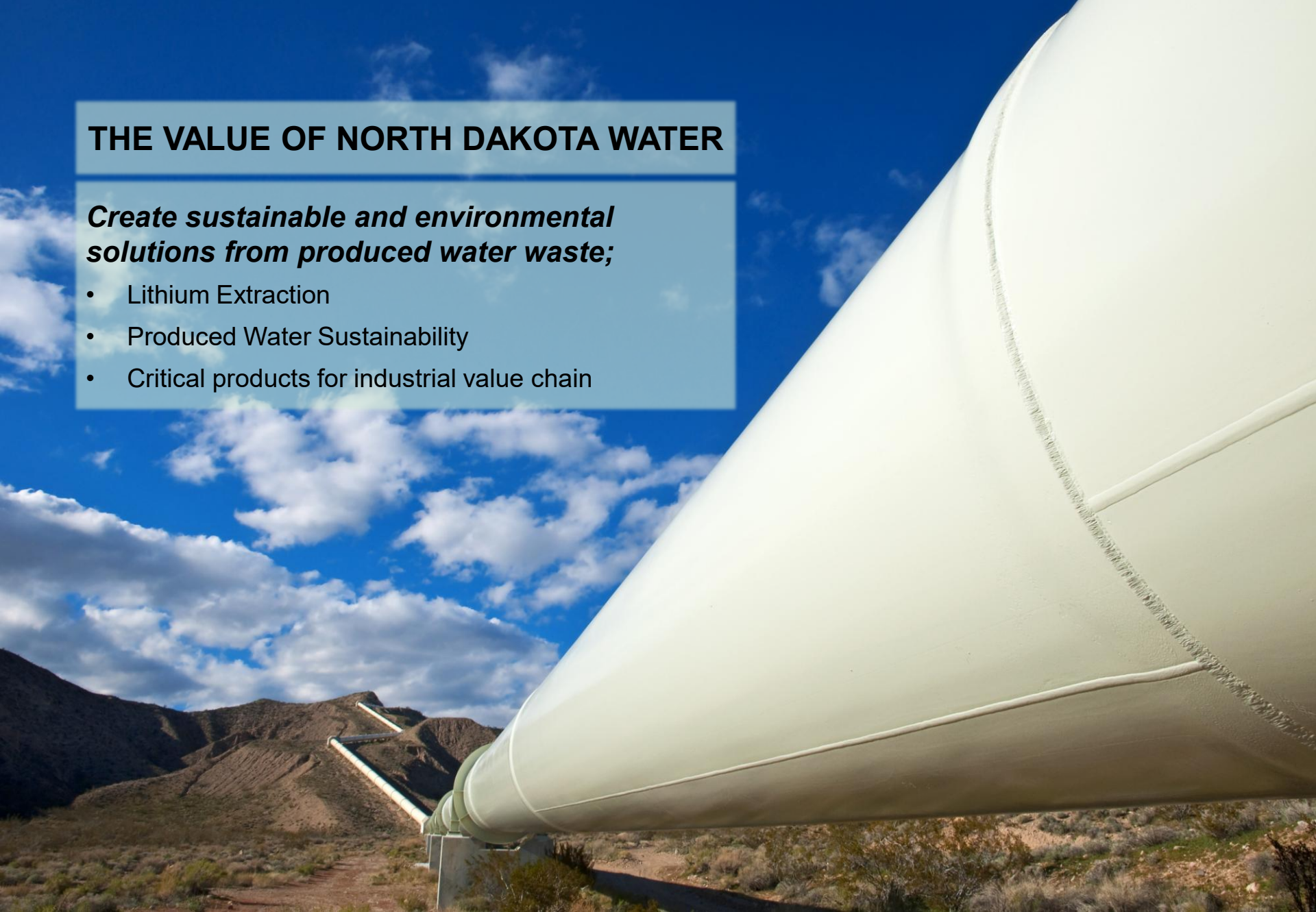
RENEWABLE SUBMISSION SCOPE

Category	Description	Cost
Lithium Testing & Qualifications	• Sampling time, travel, and equipment • 3rd party water analysis • Tenorm testing • Water concentration & Li heat map	\$90,000 USD
Pretreatment testing of water to allow for effective LiCl extraction and refining	• Solid/liquid technology down select* • 3rd party water analysis • Tenorm testing • Mass balance engineering work	\$150,000 USD
Preconcentration of LiCl	• Testing to understand concentration LiCl	\$50,000 USD
Lithium Carbonate Onsite Development	• Electrical tie in/onsite power generation – 50K • Onsite operations of 10 Ton refining unit to generate validation	\$300,000 USD
Lithium Carbonate Validation	• 3rd party testing validation • Tenorm testing • Samples, Shipping	\$160,000 USD
Testing Equipment (ICP)	• Internal water analysis, lithium validation, testing	\$250,000 USD
Total		\$1,000,000 USD

THE VALUE OF NORTH DAKOTA WATER

Create sustainable and environmental solutions from produced water waste;

- Lithium Extraction
- Produced Water Sustainability
- Critical products for industrial value chain



ABSTRACT

Objective:

The Wellspring Hydro lithium project aims to establish a sustainable direct lithium extraction (DLE) process using waste produced water from North Dakota oilfields. A field trial was completed onsite in North Dakota with a technology partner who has tested Bakken formation water and is currently running a commercial operation in West Texas.

Wellspring Hydro has invested in a pilot-scale lithium carbonate production unit as the next critical step following the successful lithium extraction field trials. Producing lithium carbonate at the pilot scale will generate bulk sample volumes suitable for testing, qualification, and pre-commercial validation by potential end users, including battery manufacturers and cathode suppliers. This investment reflects Wellspring's strategic commitment to accelerating commercialization, de-risking full-scale development, and enabling early customer validation of U.S.-produced battery-grade lithium.

Wellspring Hydro requests the financial support of the Renewable Energy Program to complete the next step of commercialization including site specific lithium extraction qualification and associated high value 3rd party testing. A major emphasis will be on lithium refining validation and samples creation with a purpose to prove the capability to meet the required quality and quantity of Lithium Carbonate for customers again validated by high value 3rd party lab testing. Packet Digital is the primary focus of validation to ensure Wellspring Hydro can meet their short and long-term product requirements for the battery cell manufacturing facility, much of this validation work will be performed in conjunction with UND and cathode cell manufacturers. This output will create a full life-cycle lithium ecosystem inside North Dakota from lithium extraction to battery manufacturing, with the potential to make the state a key player in the evolving and expanding energy market.

Expected Results:

The output of this project will result in Lithium Carbonate in Produced Water for Battery Grade Li_2CO_3 for in-state Cathode Manufacturing.

Duration:

This project will be focused over 9 months, aligned to the timing of the Refining Unit installation in North Dakota and Packet Digital's requirement for product in 2H 2026.

Total Project Cost:

Total of \$1,000,000 project cost. Wellspring Hydro is requesting \$500,00 from the Renewable Grant to support the scope.

Participants:

The project will be managed by Wellspring Hydro and LibertyStream's management teams. The project will also actively involve Packet Digital with collaboration on Lithium Carbonate validation.

PROJECT DESCRIPTION

Objectives:

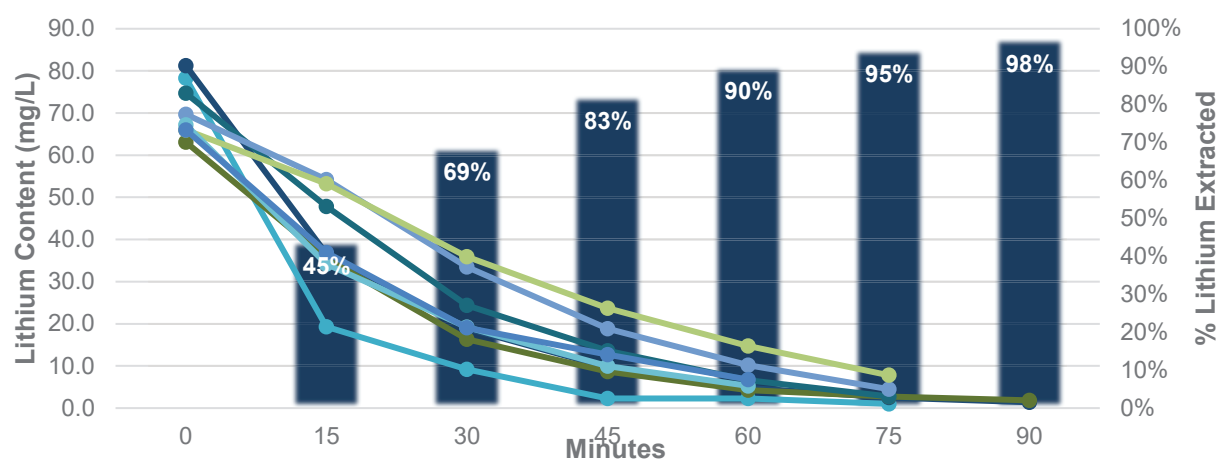
The Wellspring Hydro lithium project aims to establish a sustainable direct lithium extraction (DLE) process using produced water from North Dakota oilfields. A field trial was completed onsite in North Dakota with technology partner LibertyStream who has tested Bakken formation water and is currently running a commercial operation in West Texas.

The field trial processed raw untreated produced water to demonstrate the feasibility of lithium extraction from produced water streams. The success of this DLE pilot test had a significant impact on the scalability of lithium production in North Dakota, positioning it to become a significant producer in North America. The field trial was supported by the Renewable Energy Program funding for the following:

- Produced water lithium extraction onsite at a saltwater disposal for a 30-day field trial in 2025.
- Proprietary equipment and IX Media designed for oilfield produced water.
- Laboratory testing for validation of DLE system and IX Media performance.

The North Dakota field trial was conducted in June and July 2025 to validate lithium extraction performance of the proprietary IX Media under real-world operating conditions. The trial successfully met all expectations, consistently achieving greater than 95% lithium extraction across all DLE runs using raw untreated Bakken produced water. These results confirmed the technical viability and reliability of the process at field scale, marking a critical milestone on the path toward commercial deployment.

Based on the optimized field DLE runs, Wellspring Hydro and LibertyStream were able to extract between 90-99%. The graph below represents % lithium extracted and the changes over time.



The proprietary DLE equipment and IX (ion exchange) media performance onsite confirmed:

- The Williston Basin produced water responds similarly under laboratory, pilot plant and site conditions.
- Lithium extraction performance is consistent with comparable efficiencies.
- On-site DLE has been validated as operationally feasible and effective in the Williston Basin.

Wellspring Hydro has invested in a pilot-scale lithium carbonate production refining unit as the next critical step following the successful lithium extraction field trials. Producing lithium carbonate at the pilot scale will generate bulk sample volumes suitable for testing, qualification, and pre-commercial validation by potential end users, including battery cathode suppliers and manufacturers. This investment reflects Wellspring's strategic commitment to accelerating commercialization, de-risking full-scale development, and enabling early customer validation of U.S.-produced battery-grade lithium.

LibertyStream Infrastructure Partners and Wellspring Hydro completed a rigorous vendor selection process to identify a qualified third-party engineering and fabrication firm capable of designing and building a modular lithium carbonate production unit. The selection focused on vendors with proven experience in lithium processing, modular plant construction, and the ability to deliver high-purity lithium carbonate suitable for end-user sampling and validation. Ultimately, ENCO Machinery was selected as the vendor due to their track record in lithium projects around the world and their expertise in developing a modular cost-effective design.

To ensure the unit was tailored to its process needs, Wellspring Hydro and LibertyStream supplied lithium chloride feedstock—produced from its proprietary Direct Lithium Extraction technology—to the vendor early in the design phase. This allowed the engineering team to perform bench-scale testing and process modeling, enabling them to:

- Accurately size precipitation and filtration systems,
- Optimize for impurity removal based on brine chemistry,
- And ensure the final lithium carbonate product could meet targeted purity specifications.

The design effort prioritized field-deployable, modular architecture to allow for staged deployment—beginning with pilot-scale operations and ultimately integration with scaled commercial operations. Enco Machinery has also provided quotes on Lithium Carbonate units for annual carbonate production of 100 tons, 500 tons and 1,500 tons. Upon successful implementation of the pilot-scale (which will be used for commercial production with smaller customers) in the field, there will be an opportunity to utilize this technology for commercial operations. This custom-engineered unit serves as a key bridge between successful lithium extraction trials and commercial-scale lithium carbonate production in 2026.

Wellspring Hydro requests the financial support of the Renewable Energy Program to complete the next step of commercialization including site specific lithium extraction qualification and associated high value 3rd party testing. A major emphasis will be on lithium refining validation and samples creation with a purpose to prove the capability to meet the required quality and quantity of Lithium Carbonate for customers again validated by high value 3rd party lab testing. Packet Digital is the primary focus of validation to ensure Wellspring Hydro can meet their short and long-term product requirements for the battery cell manufacturing facility, much of this validation work will be performed in conjunction with UND and cathode cell manufacturers. This output will create a full life-cycle lithium ecosystem inside North Dakota from lithium extraction to battery manufacturing, with the potential to make the state a key player in the evolving and expanding energy market.



INDUSTRIAL COMMISSION OF NORTH DAKOTA
RENEWABLE ENERGY PROGRAM

TECHNICAL REVIEWERS' RATING SUMMARY

R-056-A

UNLOCKING LITHIUM CARBONATE IN PRODUCED WATER FOR BATTERY
GRADE Li_2CO_3 FOR IN-STATE CATHODE MANUFACTURING

Principal Investigator: Matt Hirst

Request for \$500,000; Total Project Costs \$1,000,000

TECHNICAL REVIEWERS' RATING SUMMARY					
R-056-A					
UNLOCKING LITHIUM CARBONATE IN PRODUCED WATER FOR BATTERY GRADE Li2CO3 FOR IN-STATE CATHODE MANUFACTURING					
Principal Investigator: Matt Hirst					
Request for \$500,000 Total Project Costs \$1,000,000					
Rating Category	Weighting Factor	Technical Reviewer			Average Weighted Score
		1A	3A	5A	
		Rating			
1. Objectives	9	2	4	4	30.00
2. Achievability	9	4	3	3	30.00
3. Methodology	7	4	3	3	23.33
4. Contribution	7	2	4	5	25.67
5. Awareness	5	2	3	3	13.33
6. Background	5	3	3	3	15.00
7. Project Management	2	3	3	2	5.33
8. Equipment Purchase	2	4	5	3	8.00
9. Facilities	2	4	4	3	7.33
10. Budget	2	4	4	3	7.33
Average Weighted Score		151	174	171	165.33
Maximum Weighted Score					250.00

1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Renewable Energy Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 1A (Rating 2)

This project utilizes a continuous waste product from the oil industry to extract lithium carbonate. This process would/could be the initial step in helping the USA be independent of foreign suppliers in the production of lithium batteries. Unfortunately, this project does not promote any of the renewable energy goals or purposes set forth in the NDIC Renewable Energy Council's mission statement.

Reviewer 3A (Rating 4)

The goal of the Wellspring Hydro lithium project is to establish a sustainable direct lithium extraction (DLE) process using produced water waste from North Dakota oilfields. This activity builds on a successful field test completed on ND produced water. Wellspring Hydro has invested in a pilot scale unit which they will use to produce lithium carbonate at the pilot scale by generating bulk sample volumes suitable for testing, qualification, and pre-commercial validation by potential end users. This would allow for a North Dakota based supply chain for production of Li domestically to supply the Li battery industry critical to the growing EV industry.

Reviewer 5A (Rating 4)

The goals of the project are clear, develop an environmentally and economically sustainable source of bulk lithium carbonate for battery production. This aligns with the NDIC/REC goals for development of renewable energy and related industrial uses including commercialization. The end goal is to prove-up the technology on the available feedstock and scale to full commercialization. The applicant does not estimate what full commercialization means in terms of footprint or investment requirements.

- 2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.**

Reviewer 1A (Rating 4)

Anticipated cash flow over the 9 month project life along with the milestones appear to be a bit aggressive but also achievable.

Reviewer 3A (Rating 3)

The level of detailed information on the proprietary processes involved make it hard to assess the sufficiency of the time and budget suggested. The only information given is the statements that the testing was “successful.” I would have liked to see the report to better understand what was done and offer my opinion as to the possible success of the next step suggested.

Reviewer 5A (Rating 3)

The parallel phase approach stated in the application is good. It allows for the start of phase II while finishing up phase I. The budget appears adequate for the project based on the amount of pre-work completed and the partnerships Wellspring has.

- 3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.**

Reviewer 1A (Rating 4)

The approach to achieve the extraction of lithium carbonate is outlined clearly in this proposal.

Reviewer 3A (Rating 3)

It is hard for me to evaluate this without seeing the earlier report to better understand the logical next steps.

Reviewer 5A (Rating 3)

The methodology to identify the “easy” lithium locations using the proprietary extraction technology and validating the scale to pilot production process are most likely achievable.

The methodology to the pilot/modular scale are detailed sufficiently to reach the same conclusion as above. The use of a fabricator with experience improves the likelihood of success.

There is not a lot of discussion how to clean up marginal sources to improve usage potential. It's referenced, but not explained.

4. **The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Renewable Energy Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.**

Reviewer 1A (Rating 2)

To be fair, this project can create a new and essential industry to North Dakota that leaves the United States less dependent on outside sources to produce batteries. It also utilizes a waste product from the oil fields of North Dakota. However, this proposal does not address any of the goals and purposes set forth by the NDIC Renewable Energy Council.

Reviewer 3A (Rating 4)

Success with the proposed activity would be a significant step toward establishing a North Dakota based supply chain to provide the Li required for the desired move to electric vehicles and the energy storage options this would require.

Reviewer 5A (Rating 5)

The beneficial uses of a waste stream to support a renewable adjacent industry using ND resources provides a direct and quantifiable contribution to the NDIC/REC goals along with being able to bring another “value add” to the development of the ND economy and ND based technology industry.

5. **The principal investigator's 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: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.**

Reviewer 1A (Rating 2)

I understand the process and the chemicals listed in this proposal but have not been exposed to the battery manufacturing process (what the lithium carbonate is eventually used for). I have not been exposed to the research activity or literature in the past. From this proposal I have gathered that the science of removing the lithium carbonate from the oil field wastewater has been developed and is utilized elsewhere. This proposal brings this process to the oil fields of NW North Dakota where substantial amounts of lithium can be recovered.

Reviewer 3A (Rating 3)

The team assembled appear qualified. This includes the two universities, UND and NDSU, both have several professionally qualified experts that could add significantly to this work. Unfortunately, they are not identified nor are the expected contribution clarified. Also, it would be expected that the proposal includes a letter of commitment from any groups that are relied on to support the activities.

Reviewer 5A (Rating 3)

The investigator and partners have ‘real world’ experience in lithium refining. As this is a bench to pilot project, the knowledge of current research activity carries a lower weight. That being said, the partners mentioned in this project do have the awareness required to be resources.

- 6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.**

Reviewer 1A (Rating 3)

I have a master's degree in chemical engineering and almost 40 years of industrial experience. I have reviewed many budgets and proposals over this time. Skids are readily assembled and commissioned when nothing new is being designed so the timetable can work. However, the North Dakota winters for such a project can extend the completion date a bit.

Reviewer 3A (Rating 3)

The team members noted have been successful in bringing the technology to this point. The indicates they have the background necessary to be successful.

Reviewer 5A (Rating 3)

The investigator and development partners have or are involved various oil and gas projects but more importantly, value extraction from produced (brine) water. The investigative experience gained from previous brine projects is applicable to this endeavor.

- 7. 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: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.**

Reviewer 1A (Rating 3)

The proposal calls for a start in January, 2026 and conclude in September, 2026. Starting a project like this in NW North Dakota (personal opinion) may not be the best time to get an outdoor project off to a running start. The cash flow is cited in the proposal without timelines. The communications part is also covered within the proposal.

Reviewer 3A (Rating 3)

The proposal includes milestones and a communication plan that are adequate.

Reviewer 5A (Rating 2)

The application only states a report and completion timeline and a generic communication management process. The milestones listed are adequate, but no timeline is included. Communications management with partners is stated, but no details.

- 8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)**

Reviewer 1A (Rating 4)

The equipment cited is essential for this project. A modular lithium carbonate production unit was the only equipment cited in this proposal.

Reviewer 3A (Rating 5)

No equipment will be purchased.

Reviewer 5A (Rating 3)

The applications is not specific on “bench testing equipment” or “water testing equipment” other than the technologies used. This information was not fully developed as to make and model of equipment.

9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 1A (Rating 4)

A designing and construction company for the modular unit has been cited in this proposal.

Reviewer 3A (Rating 4)

The noted facilities are well suited to achieving the goals of this project.

Reviewer 5A (Rating 3)

Same as 8.

10. The proposed budget “value”¹ relative to the outlined work and the financial commitment from other sources² is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Reviewer 1A (Rating 4)

From the national security aspect, the manufacturing of batteries with all materials provided by US companies is essential. This proposal outlines a means to provide the lithium necessary to do as such from a waste resource without environmental impact. Unfortunately, this is not a project that utilizes renewable energy resources from the state of North Dakota. The proposal cites that the produced batteries can be for electric vehicles which are recharged off the grid which may or may not be from renewable sources. The proposal does have a commitment of 50% from private industry.

Reviewer 3A (Rating 4)

The proposed project includes the required 50% cost share. The funding is supplied by a commercial company which is good. This level of investment by the private sector represents their commitment to moving forward to a commercial product which is a major goal of this NDIC program.

Reviewer 5A (Rating 3)

Given the 50/50 match with the partners gives the NDIC/REC a high value. Any equipment purchased will remain in the possession of the investigator.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 1A

I am fascinated by this proposal and believe it would be an awesome project in the state of North Dakota. There is a ready market in the state that would like this project to be completed (including the University of North Dakota). I do believe this is a worthy investment for the state of North Dakota but, the NDIC Renewable Energy Council is not the place to provide the funding as this project fails to meet any of the goals and purposes set forth in the REC’s mission statement. Therefore, I cannot recommend funding this proposal.

Reviewer 3A

I would suggest funding should be considered. I like what I see as the goal of this activity, establishing a commercially viable supply chain in ND for Li in battery technology. I would have been a stronger supporter of this effort if additional information had been provided, namely the report of the successful test in June and July of this year. Including more information on the proprietary technology to be used.

Reviewer 5A

Overall, this is a very good project for the State of ND and the country as a whole. As stated above, the value of using a waste stream to produce a needed commodity in North Dakota is very high. This project has the potential to develop into a large industry that is anchored in the state.

Recommend to fund the project.

**Renewable Energy Program
Grant Round 56
Application Summary Page
R-056-B**

Project Title: Empowering the Critical Minerals for Novel Cathode Materials-based Drone Batteries

Applicant: University of North Dakota

Primary Contact: Xiaodong Hou

Total Project Costs: \$1,000,000

REP Request: \$500,000

Summary of Project: Develop advanced cathode materials to enable next-generation Li-ion batteries for drone applications, and establish a Battery Materials Qualification & Testing Lab to ensure that synthesized cathode materials meet the requirements for Packet Digital's new cell manufacturing facility in Fargo.

Technical Reviewer Comments: (Overall Score 184 out of 250)

- In my opinion, this is a valuable project for the state of North Dakota. If governmental assistance is required for this research to continue, I believe funding should be given. Just not here, as it does not meet any of the goals and purposes set forth in the NDIC Renewable Energy Council's mission statement. Personally, if I didn't believe this project was so worthwhile, I would have thrown this request out based on how poorly the proposal was written, along with the fabricated economic support. The University should care enough about their work and receiving funding that they would put in the effort to assure that their request is not written in such a manner as this one.
- This is a good project. This project will be positive for the stakeholders and the state. I would have liked the lab to be established at UND or the NDSU industrial park, so the funds would be used for long-term educational/lab equipment.
- The proposed project integrates a range of North Dakota resources to achieve a fully domestic supply chain for critically needed battery technology. Very importantly, it not only defines the technical path to successfully developing the technology. It includes plans for the next steps that would lead to an operation in North Dakota that would allow the state to gain significant financial benefit.

REP Advisory Board Recommendation: Fund



Empowering the Critical Minerals for Novel Cathode Materials-based Batteries

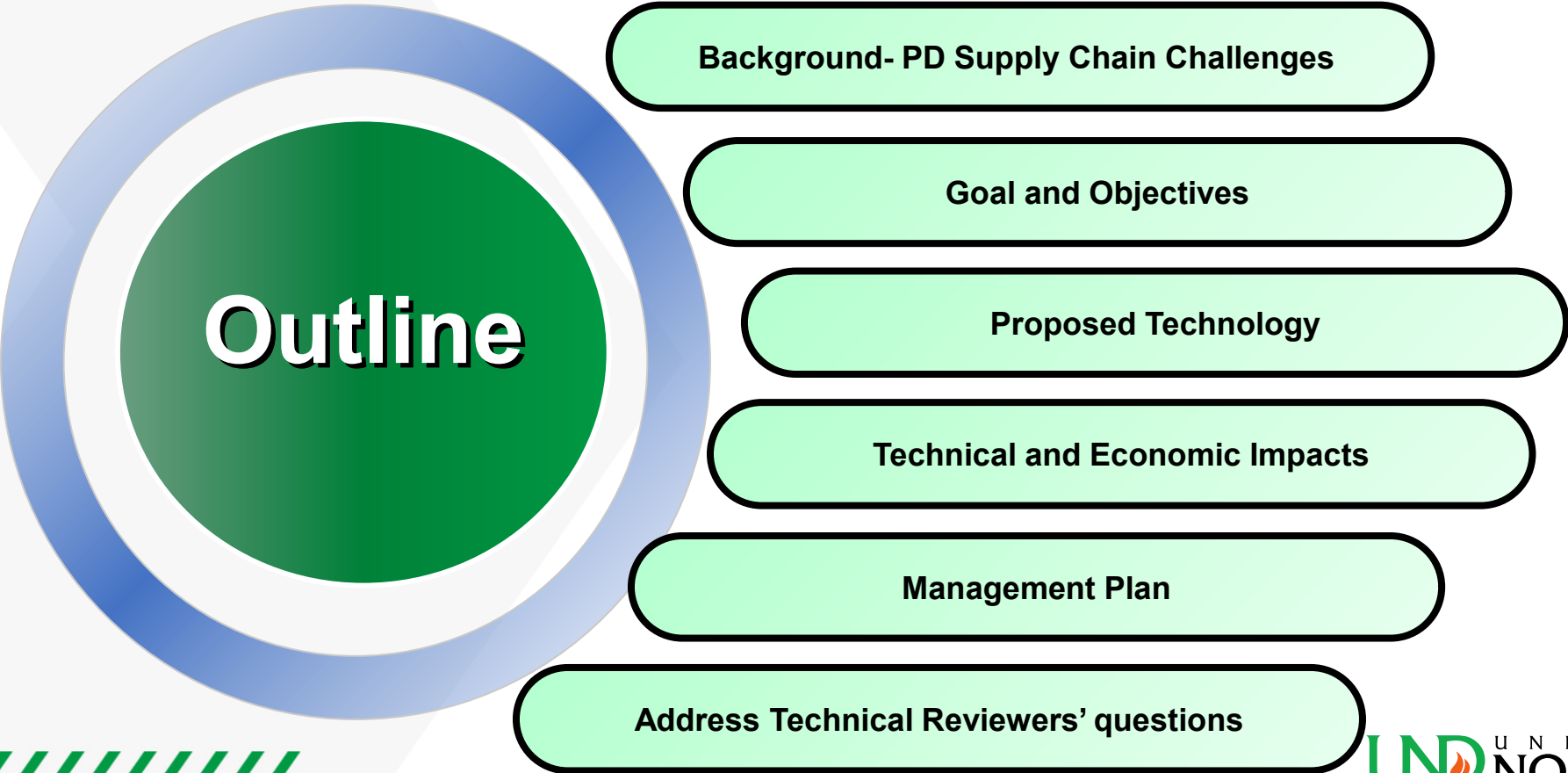
Principal Investigator: Xiaodong Hou

Applicant: UND College of Engineering and Mines

Subcontractor: Packet Digital LLC (Dr. Peng Liao)

10-21-2025

Outline



Outline

Background- PD Supply Chain Challenges

Goal and Objectives

Proposed Technology

Technical and Economic Impacts

Management Plan

Address Technical Reviewers' questions

Center for Process Engineering Research (CPER)

- Found in 2009
- One unit under CEM
- Mission: Energy Research-Education-Outreach
- Personnel (>25): Faculty, Engineers, and students
- Strong Industrial Collaboration
- Facilities
 - Advanced UAV and Satellite Materials Characterization Lab
 - Bench and **Pilot** Facilities
 - Modeling and Simulation

Use of fossil fuels in a **carbon constrained environment** / **carbon management**:

- Capture of CO₂ using sorbent materials
- Novel combustion technologies
- New products from coal

Recovery of valuable/**critical materials**:

- Recovery of **rare earth elements** from coal and coal by-products
- Recovery of lithium, nickel and other valuable materials from oil field process waters
- Rare earth value chain including recovering other critical materials
- Co-producing graphene and rare earth elements from Leonardite and lignite

Building a **renewable energy** portfolio – moving beyond fossil fuel:

- Li-ion/Na-ion batteries (cathode/Anode material development, battery management systems)
- Developing and integrating energy storage devices into the grid – chemical (battery); thermochemical (CLC), and others
- Energy policy using system dynamic analysis
- Geothermal energy development

Packet Digital: Batteries for Renewable Energy!

150



Over 150 years of engineering experience

15



13 patents awarded
2 patents pending

18+



Battery deployed in the field for over 18 years



Battery designed and produced in US

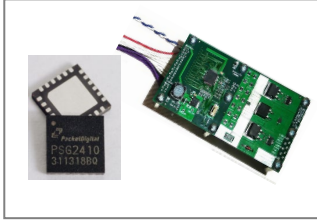
Raw Material
& Battery Cell



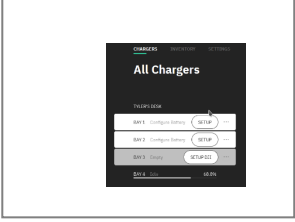
Battery management



Electronics designed



Battery integration & Software



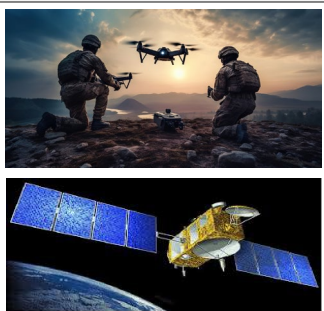
Renewable Energy:
Storage Battery



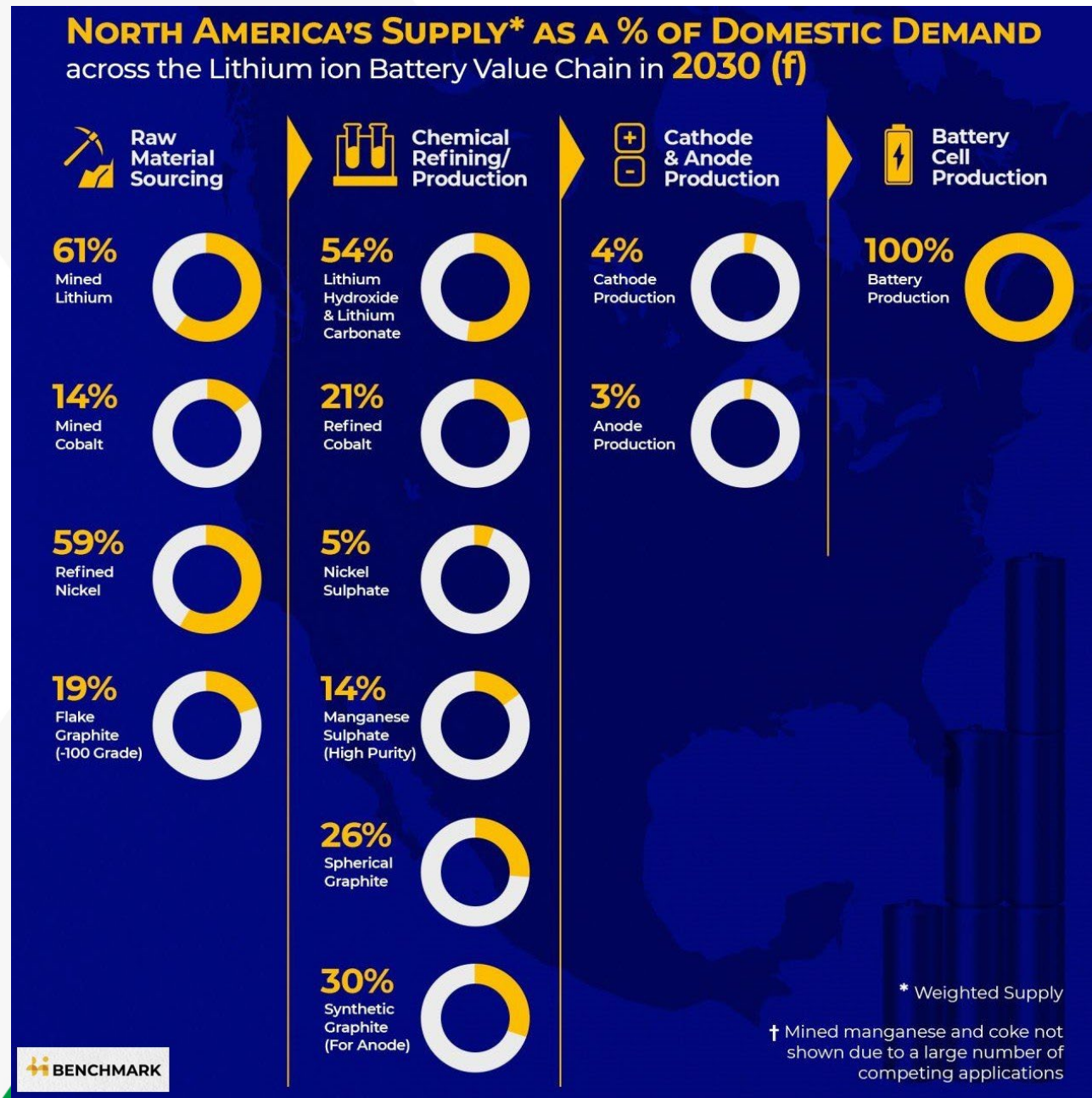
Renewable Energy:
Robots



Renewable Energy:
Electric Aviation



Battery Supply Chain: A Severe Issue for the United States



Battery Supply Chain: A Great Opportunity for North Dakota

A Complete Battery Ecosystem for Renewable Energy Industries



“Immediate Measures to Increase American Mineral Production”

57 La Lanthanum 138.91	58 Ce Cerium 140.12	31 Ga Gallium 69.723	32 Ge Germanium 72.630	6 C Carbon 12.011
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1. North Dakota Critical Minerals

3 Li Lithium 6.94	28 Ni Nickel 58.693	27 Co Cobalt 58.933	29 Cu Copper 63.546
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**WELLSPRING
HYDRO INC**
Li₂CO₃ from oil waste water

+

**TALON
METALS CORP**
NCM Precursors

+

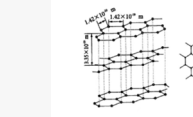
**UND
UNIVERSITY OF
NORTH DAKOTA**
Rare-Earth-Elements (REEs)

- Environmental friendly!
- Focus on CMs recycling!
- Direct recycling, promising for sustainability & economics!

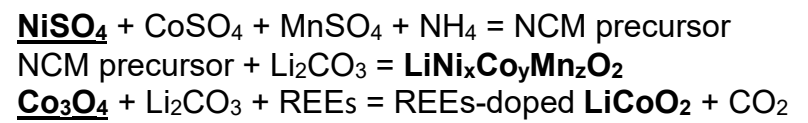
5. Recycling



4. Renewable Energy Industries



2. Material Processing



3. Badland Batteries Cell & Pack Manufacturing



“Unleashing American Energy”

- More than 95% Made-in-China!
- AI-powered cell RD & manufacturing!
- 25,000 sf pack production plant!
- 80,000 sf cell production plant!

PacketDigital



“Unleashing American Drone Dominance”

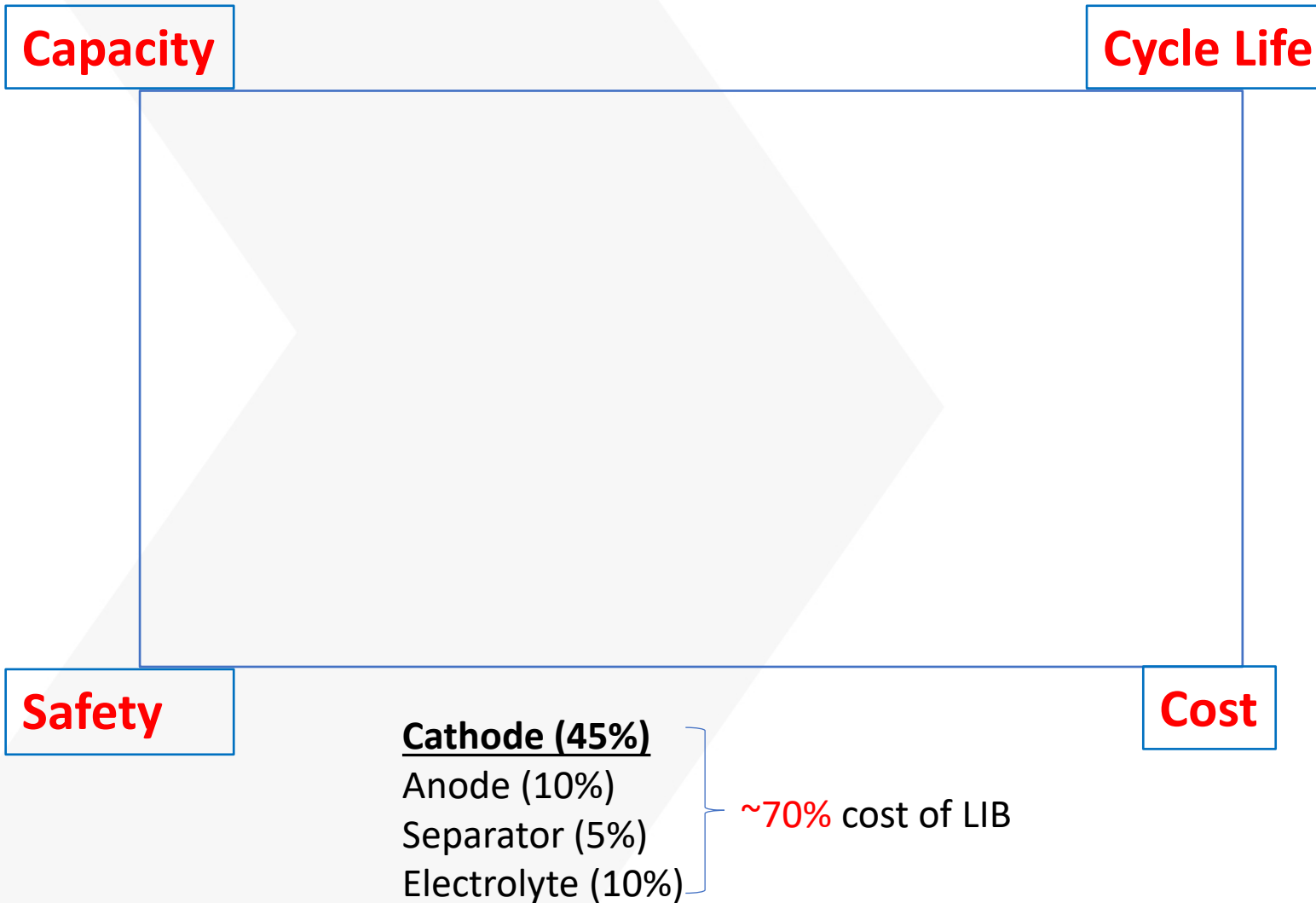


“Renewable Energy Program Mission: Foster the development of renewable energy and related industries”



**UND
UNIVERSITY OF
NORTH DAKOTA**
COLLEGE OF ENGINEERING & MINES

Background: Lithium-Ion Battery (LIB)



Goal and Objectives

- **Goal:**

- Establish a closed-loop North Dakota supply chain for advanced drone batteries, eliminating reliance on foreign suppliers while meeting U.S. energy security and urgent defense needs



Goal and Objectives

- **Key Objectives**

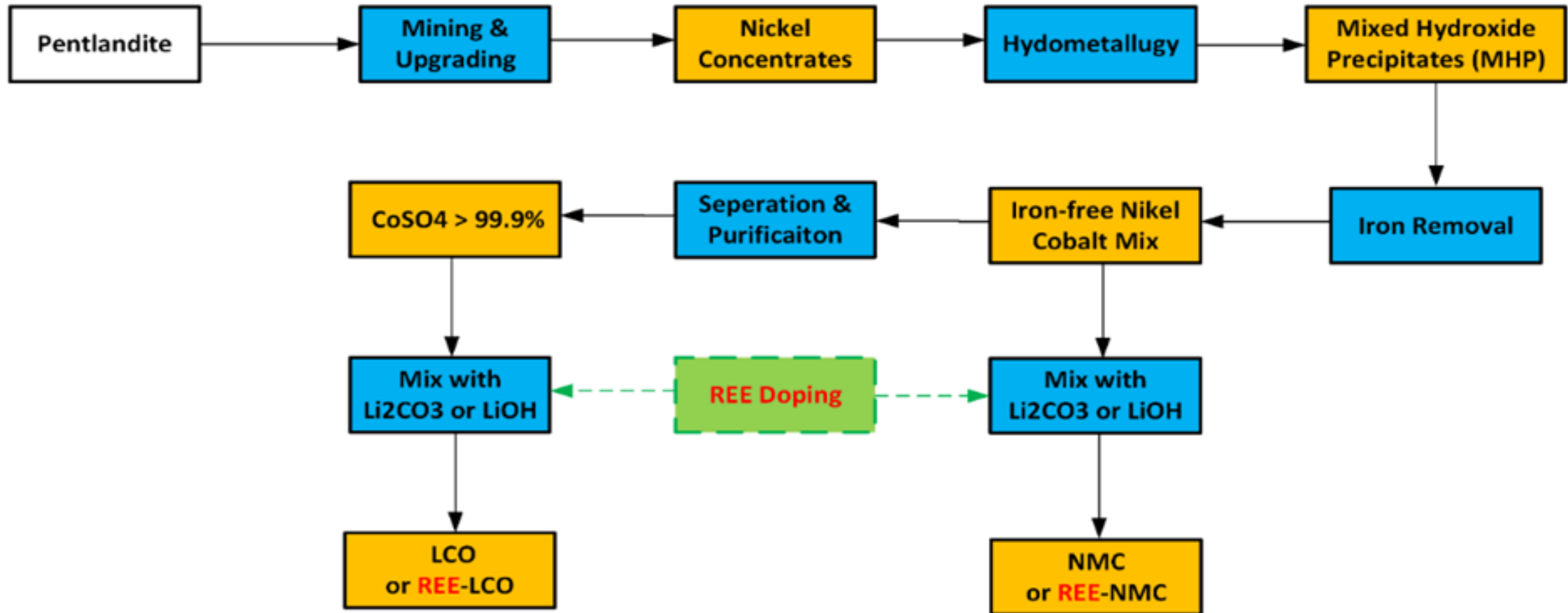
- Development of a lab-scale Ni and Co separation & purification process
- Synthesis of advanced cathode materials NMC and LCO
- Process design for the pilot-scale production of Ni & Co precursors and cathode materials
- Evaluate the battery performance of the cathode materials
- Building a Battery Materials Qualification & Testing Lab



Technical Basis

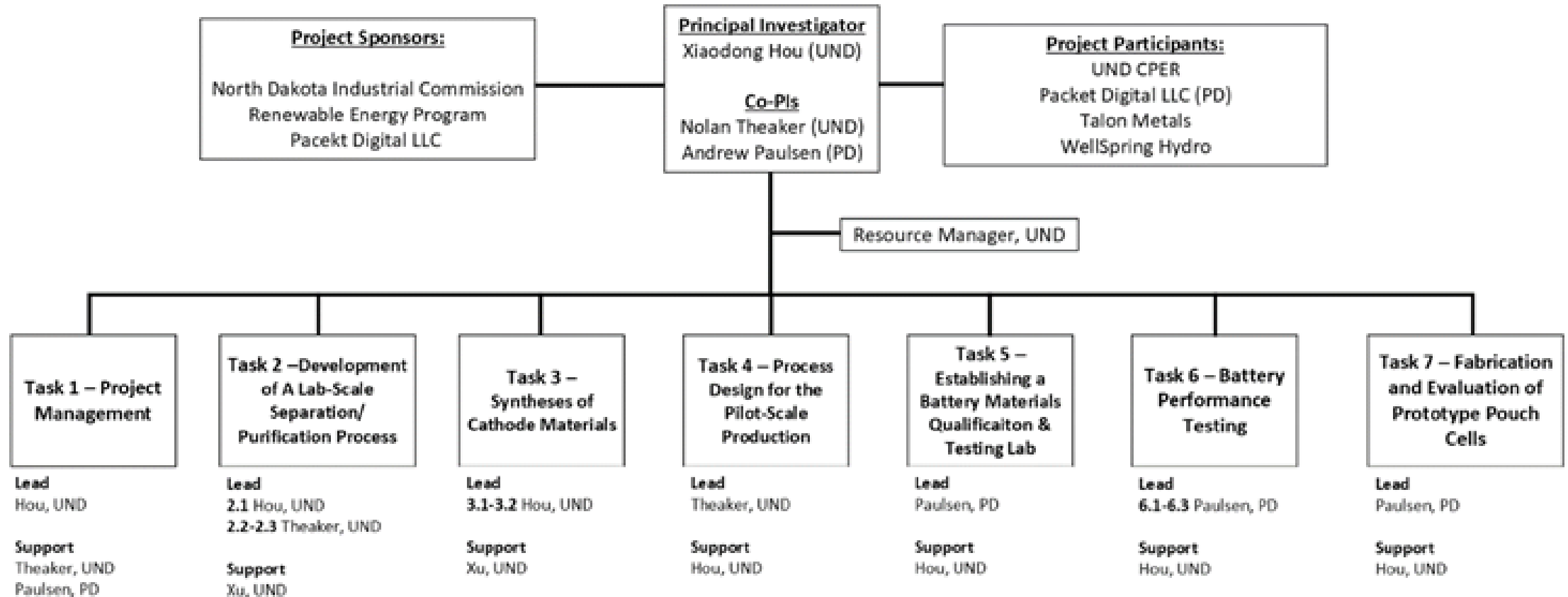
- 1) Talon Metals and its partners (University of Columbia and Argonne National Laboratories)'s ongoing R&D projects aiming to produce Nickel MHP from Talon Metals' Nickel concentrates.
- 2) Wellspring Hydro's Li precursor sources through its Direct Lithium Extraction technology from ND's produced water
- 3) UND's expertise and facility in the Rare Earth Element (REE) extraction from lignite
- 4) UND's 10+ years' experience in battery materials R&D
- 5) PD's industry-leading smart battery manufacturing technology over 20 years' drone battery manufacturing experience
- 6) PD's DoD clients' extremely strong support

The Proposed Technology

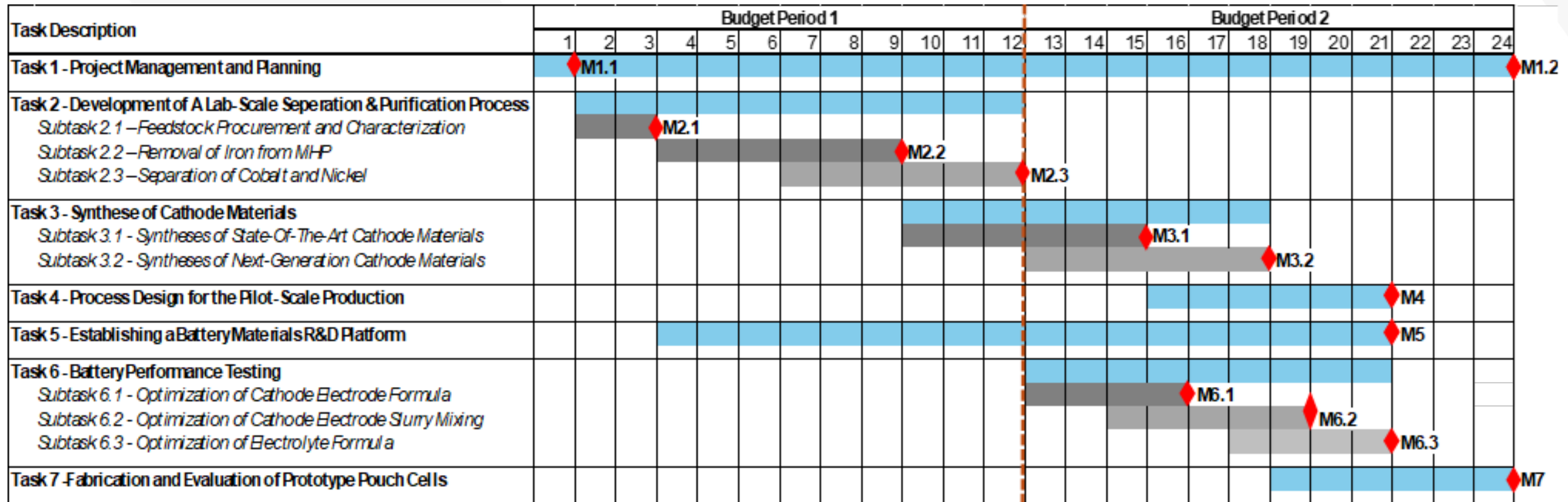


Management Plan: Organization Structure

Figure 2. Project organization



Management Plan: Timeline



Budget

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (in- kind)	Industry Partners' Share
Personnel	130,745	55,790	-	
Fringe Benefits	36,521	20,642	-	28,901
Travel	-	-	-	2,518
Equipment	-	-	-	38,427
Supplies	5,250	-	-	
Subcontracts	225,000	-	-	-
Other Direct Costs	16,785	42,230	-	20,000
Indirect Costs	85,699	31,337	-	260,154
Total	500,000	150,000	-	350,000

	PD Budget (\$)	Packet Digital Cost Share (\$)	NDIC Share (\$)
Personnel (Salary)	\$100,910	\$0	\$100,910
Fringe Benefits	\$28,901	\$28,901	\$0
Travel	\$2,518	\$2,518	\$0
Cell RD Equipment	\$161,517	\$38,427	\$123,090
Supplies	\$1,000		\$1,000
Other Direct Costs			
In-kind Cost Share (Talon Metals)	\$20,000	\$20,000	
Indirect Costs	\$260,154	\$260,154	
Total	\$575,000	\$350,000	\$225,000

Technical and Economic Impact

- Strengthen PD's capabilities in securing domestic battery supply chain, positioning it as a leader in next-generation drone batteries
- Expand market opportunities for Talon Metals and Wellspring Hydro by creating new customers for their feedstocks
- Transform North Dakota's rich critical minerals and renewable energy assets into high-value products, driving national technological leadership
- Stimulate investment, create highly skilled jobs, and foster regional economic development through critical minerals mining, advanced manufacturing, and energy innovation



Technical and Economic Impact

- Next-generation Renewable Energy Workforce Development
 - **Interdisciplinary Renewable and Environmental Chemistry REU Program at UND**
 - **Chem-E-Car competition**

Our Responses to Technical Reviewers' Questions

- **Reviewer 1B**

Q1 Objectives & Q4 Contribution: “This project does not promote any of the renewable energy goals or purposes set forth by the NDIC Renewable Energy Council”

Q5 Awareness: “This proposal does not utilize any of North Dakota’s renewable energy resources “

Overall Comments and Recommendation: “It does not meet any of the goals and purposes set forth in the NDIC Renewable Energy Council’s mission statement “



Our Responses to Technical Reviewers' Questions

- **Reviewer 1B**

Q10 Budget:

- The university's contribution (PI's salaries, fringe benefits, tuition waivers) would be better described as "in-kind". In my experience, this was called contingency or padding when submitting proposals.
- Talon Metals' \$20 cost-share has no breakdown of each component.
- Packet Digital's fringe benefits and indirect costs, which is almost 88% of their support.
- I do not believe that 50% of the total project comes from other sources

Q6 Background:

- Evidently this proposal was not proofread before submitting it for review.
- There are grammatical, punctuation, spelling, and capitalization errors throughout this proposal.



Our Responses to Technical Reviewers' Questions

- **Reviewer 2B**
- Overall Comments
 - I would have liked the lab be established at UND or the NDSU industrial park so that the funds would be used for long term educational/lab equipment.
- Q8 Equipment
 - The project will be extremely difficult to proceed without the on-site equipment. While not be directly purchased with NDIC funds, the project as a whole will be acquiring equipment.

Acknowledgement

Sponsors

- NDIC Renew Energy Program

Partners

- Talon Metals
- Wellspring Hydro



1 ABSTRACT

Objective: The Center for Process Engineering Research (CPER) at the University of North Dakota (UND) College of Engineering & Mines, in collaboration with Packet Digital LLC (PD), will lead the development of advanced cathode materials to enable next-generation Li-ion batteries for drone applications. As part of this effort, UND and PD will also establish a Battery Materials Qualification & Testing Lab to ensure that synthesized cathode materials meet the requirements for PD's new cell manufacturing facility in Fargo. This pilot project will integrate North Dakota's critical mineral resources—nickel and cobalt from Talon Metals, lithium from Wellspring Hydro, and rare earth elements produced by UND—to demonstrate a fully domestic pathway for innovative cathode materials such as lithium cobalt oxide (LCO) and nickel manganese cobalt oxide (NMC).

Expected Results: This project will focus on the development of advanced cathode materials at lab-scale as the foundation for next-generation Li-ion batteries. It will also establish a Battery Materials Qualification & Testing Lab at PD's manufacturing facility. By the end of the project, we expect to deliver battery-grade nickel and cobalt precursors, prototype cathode materials Lithium Nickel Manganese Cobalt Oxide (NMC) ($\text{LiNi}_x\text{Mn}_y\text{Co}_z\text{O}_2$, where $x+y+z \approx 1$) and Lithium Cobalt Oxide (LiCoO_2) and the associated synthetic processes, battery performance testing results in both coin and pouch cells formats, determining their feasibility for PD's drone applications, and a process design for pilot-scale cathode materials production. The successful completion of this effort will position us for the next phase of pilot scale production, supported by techno-economic analysis (TEA), life-cycle assessment (LCA), and a Business Plan. Together, these results will lay the foundation for commercial licensing and the establishment of pilot-scale manufacturing capacity in North Dakota.

Duration: 24 months (Suggested: November 1, 2025 – October 30, 2026)

Total Project Cost: NDIC Share: \$500,000 | Total Project: \$1,000,000

Participants: UND, Packet Digital LLC, Talon Metals, and Wellspring Hydro.

2 PROJECT DESCRIPTION

2.1 Objectives

Our goal is to establish a closed-loop North Dakota supply chain for advanced drone batteries, eliminating reliance on foreign suppliers while meeting U.S. energy security and urgent defense needs. By integrating lignite-derived rare earth elements, critical minerals, and lithium from produced water with local cell manufacturing, this project links resources extraction, materials innovation, and battery manufacturing into a single regional ecosystem.

The objectives include:

1. Development of a lab-scale separation & purification process that can produce battery-grade nickel and cobalt precursors (iron<10 ppm) from Mixed Hydroxide Precipitate (MHP) feedstock supplied by Talon Metals.
2. Synthesis of advanced cathode materials NMC and LCO with quality superior to commercial counterparts from the purified nickel and cobalt precursors, along with Li precursors (i.e., LiOH or Li₂CO₃) supplied by Wellspring Hydro.
3. Process design for the pilot-scale production of Nickel Cobalt precursors and cathode materials.
4. Development of cell prototypes to evaluate the feasibility of the cathode materials for drone battery application.
5. Building a Battery Materials Qualification & Testing Lab with the key personnel, equipment and facility secure.

The achievement of these objectives leverages the following key components:

- 1) Talon Metals and its partners (University of Columbia and Argonne National Laboratories) 's ongoing R&D projects aiming to produce Nickel MHP from Talon Metals' Nickel concentrates.
- 2) UND's expertise and facility in the Rare Earth Element (REE) extraction from lignite feedstock, a hydrometallurgical process highly synergistic to the proposed purification of MHP.
- 3) Local Li precursor sources supplied by Wellspring Hydro, which has developed a Direct Lithium Extraction technology from ND's produced water with its partner Volt Lithium.
- 4) UND's 10+ years' experience in battery materials R&D, including cathode and anode materials synthesis and characterization facility, battery fabrication and testing equipment, and intelligent modeling capability based on COMSOL's battery design module.
- 5) PD's industry-leading smart battery manufacturing technology and over 20 years' drone battery manufacturing experience.
- 6) PD's DoD clients' extremely strong support, including a recent \$17M contract by Navy to appeal PD to secure domestic supply chain for the military use drone battery.

The proposed project will address key technical gaps identified from prior technology

development efforts. Specific objectives related to addressing these gaps and targeting specific improvements to the baseline performance and their technical performance are listed in **Table 1**. The baseline for most of the technical objectives is based on the commercial counterparts currently used in drone batteries.

Table1. Target Level of Performance

Objective/Goal	Metric	Min Target	Baseline Performance
Nickel Precursor	Purity as $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ or $\text{Ni}(\text{OH})_2$	>99.0%	Commercial sources
Cobalt Precursor	Purity as $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ or $\text{Co}(\text{OH})_2$	>99.0%	Commercial sources
Fe impurities	Iron impurities in precursors	<50ppm	Commercial sources
Fe impurities	Iron Impurities in Cathode Materials	<50ppm	Commercial NMC811 and LCO
NMC cathode materials	Specific capacity (mAh/g)	>170	Commercial NMC811
	Initial Columbic Efficiency (ICE)	85%	
LCO cathode materials	Specific capacity (mAh/g)	>140	Commercial LCO
	Initial Columbic Efficiency (ICE)	90%	

2.2 Methodology

A high-level summary of the proposed technology is provided below (see **Appendix 2** for full confidential details). As shown in **Figure 1**, the process starts with Talon Metals extracting nickel concentrates (~10%

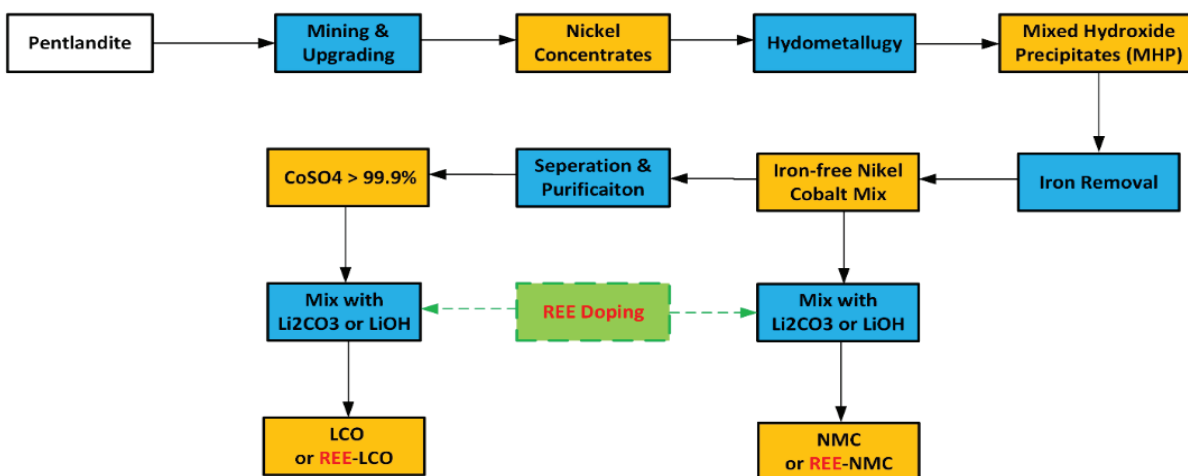


Figure 1. Flow Chart of the Advanced Cathode Materials Synthesis Process

Nickel) from pentlandite ore via advanced mining and beneficiation techniques. These concentrates undergo hydrometallurgical processing by the University of Columbia and Argonne National Laboratories, yielding mixed hydroxide precipitates (MHP, ~50% Nickel). Subsequently, UND executes iron removal from the MHP, followed by precise separation & purification protocols to isolate a high-purity iron-free

nickel-cobalt mixture, or further separate cobalt from Nickel to yield cobalt sulfate with a purity exceeding 99.9%. This refined Ni-Co mixture (or cobalt sulfate) is then blended with lithium carbonate (Li_2CO_3) or lithium hydroxide (LiOH) supplied by Wellspring Hydro to form precursor solutions for synthesizing cathode materials NMC (or LCO). UND will not only produce state-of-the-art LCO and NMC, but also develop next-generation cathode materials through the strategic incorporation of rare earth element (REE) doping to enhance battery performance.

Advantages of the Proposed Technology Over Competing Ones

- 1) *Integrated supply chain.* Unlike competitors that rely on imported precursors, this project leverages North Dakota resources (Ni/Co, Li, REEs) to create a fully domestic, closed-loop supply chain.
- 2) *Superior purity.* Delivers battery-grade Ni-Co precursors at >99.9% purity with Fe <10 ppm, exceeding typical outputs from competing hydrometallurgical processes.
- 3) *Reduced processing complexity.* Selective iron removal and optimized separation minimize the need for repeated pH adjustments, precipitation, and other solution-preparation steps, lowering costs and simplifying operations compared to standard leach-and-refine routes.
- 4) *Next-generation innovation.* Goes beyond baseline NMC and LCO synthesis by incorporating REE doping to enhance battery performance, directly supporting PD's need for higher-energy, higher-power and higher-safety cathode materials for drone batteries—a capability rarely available through conventional supply chains.
- 5) *Synergy with REE processes.* Leverages UND's established rare earth element extraction expertise and infrastructure, lowering development costs and accelerating scale-up compared to standalone technologies.

Work Plan

We propose the following set of tasks to achieve the project objectives.

Task 1 – Project Management

UND will perform all project management work necessary to manage the project's scope, schedule and budget (see Sections 5, 6, & 7). UND CPER will lead the effort in collaboration with PD, Talon Metals and Wellspring through bi-weekly meetings, with milestone reviews every quarter. UND will be responsible for communication with NDIC Renewable Energy Program in terms of financial status and technical progress reports.

Task 2 Development of A Lab-Scale Separation & Purification Process

This task aims to produce battery-grade nickel and cobalt precursors such as $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ and $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$

with iron less than 10 ppm from nickel Mixed Hydroxide Precipitate (MHP) feedstock supplied by Talon Metals.

Subtask 2.1 – Feedstock Procurement and Characterization: Nickel and cobalt-containing feedstock Mixed Hydroxide Precipitate (MHP) will be supplied by Talon Metals. The chemical composition of the MHP feedstock will be analyzed to determine the impurities' type and concentrations using an inductively coupled plasma atomic emission spectrometer (ICP-AES). The chemical analytical results will enable us to identify the optimal separation & purification strategies in the following tasks.

Subtask 2.2 – Removal of Iron from MHP: This subtask focuses on efficiently removing iron impurities from mixed hydroxide precipitate (MHP) to improve the purity of the target nickel and cobalt stream. The plan involves evaluating chemical and/or physical separation methods, optimizing process parameters such as pH, temperature, and reagent concentration, and performing lab-scale experiments to quantify iron removal efficiency. Results will guide the selection of the most effective approach for integration into subsequent nickel/cobalt separation and purification steps.

Subtask 2.3 – Separation of Cobalt and Nickel: This subtask focuses on the separation and purification of cobalt and nickel from the refined MHP. Process conditions, including feed rate, pH, temperature, and time will be optimized to maximize yield and purity. The structure and composition of the resulting cobalt and nickel precursors will be characterized by using X-ray-diffractometer (XRD), Scanning Electron Microscope (SEM) and ICP-AES. The results will be compared with commercial reference materials and the objectives defined in **Table 1**.

Task 3 – Syntheses of Cathode Materials

Subtask 3.1 – Syntheses of State-Of-The-Art Cathode Materials. This subtask aims to produce state-of-the-art cathode materials (LCO and NMC) for PD's drone batteries using the nickel and cobalt precursors produced in Task 2, along with lithium carbonate Li_2CO_3 (or Lithium hydroxide LiOH) supplied by Wellspring Hydro. The cathode materials' phase purity and yield as a function of synthetic process parameters such as precursors feeding ratio, reaction time and temperature, atmospheric will be systematically investigated. The power samples need to be further size classified to achieve desired particle size distributions. The characterization methods used in Subtask 2.3 will be applied to measure the chemical composition of the cathode materials. Particle size and specific surface areas will be measured by using a BET surface area analyzer. The results will be compared with PD's current commercial cathode materials and the performance targets defined in **Table 1**.

Subtask 3.2 – Syntheses of Next-Generation Cathode Materials. This subtask aims to prepare next-generation LCO and NMC cathode materials through doping strategies with the goal of improving the rate capability, cycling life and thermal stability of PD's next-gen drone batteries. The basic process is like the Subtask 3.1 except for the addition of a few % of REE and other dopants. The impact of dopant's type and concentration on the battery performance in particular the rate capabilities will be systematically studied.

All the characterization approached used in Subtask 3.1 will be applied in this Subtask. The doping concentration in the final cathode materials will be analyzed by ICP-OES. The battery performance including rate capability, cycling life and thermal stability will be tested by PD in the form of coin cells.

Task 4 – Process Design for the Pilot-Scale Production.

This task aims to design a pilot-scale process for the production of cathode materials, building on the lab-scale processes developed in Tasks 2 and 3. The design encompasses feedstock procurement, separation and purification of nickel and cobalt, cathode materials synthesis, and post-treatment, aiming for a reproducible and efficient operation at a scale of about 25 tons/year. The process design will identify critical process parameters, select appropriate equipment, and establish robust process control strategies to ensure product quality, operational safety, and scalability for future commercial production. While this project focuses solely on process design without executing scale-up testing, it leverages the existing bench and pilot-scale units at UND's REE Pilot Plant to inform design decisions with scale-relevant data, minimizing risks and enhancing feasibility for future pilot-scale implementation.

Task 5 – Establishing a Battery Materials Qualification & Testing Lab.

This task aims to establish a battery materials qualification and testing lab at PD's facility to support evaluation of cathode materials developed in the previous tasks, with a primary focus on performance testing. The lab will provide shared capabilities for verifying material quality, conducting critical electrochemical testing, and ensuring compatibility with PD's in-house manufacturing requirements. Importantly, this lab fills a critical gap not addressed by UND's existing battery R&D infrastructure, serving as a dedicated resource for on-site material qualification. It will cover cell design and prototyping activities, strengthen collaboration among project partners, and contribute to a more resilient domestic battery supply chain. The lab building was completed as a part of the construction of PD's new cell factory. Some of the key equipment and facility in the lab, including the coin-cell and pouch cell assembly line and testing instruments, have been procured. The main effort of this task will be calibration and testing of those existing equipment, and procurement of necessary new equipment, and make the lab fully functional. Key equipment to be installed and calibrated includes slurry mixers, precision electrode coaters, calendaring machines, electrode punching and slitting tools, electrode drying ovens, glove boxes, coin and pouch cell assembly lines, electrolyte filling systems, formation and cycling testers, and advanced analytical instrumentation for electrochemical and materials characterization. Three new equipment to be procurement include a particle size analyzer, BET surface area analyzer and moisture content analyzer. PD will lead this task.

Task 6 – Battery Performance Testing.

This task aims to evaluate the battery performance of the synthesized LCO and NMC cathode materials in small coin-cells to see if they meet the performance targets defined in **Table 1** and determine the

feasibility of being used in PD's battery fabrication when scaled up in the next phase. CR2032 coin-type cells will be prepared using lithium metal as the counter electrode. Electrochemical performance testing, including initial charge-discharge capacity, ICE, and anode cycle life, will be conducted on a TOB CT-4008 battery testing system, Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) tests will also be conducted on a Gamry potentiostat. This task including three subtasks below is to be accomplished in the newly established battery research lab in Task 5.

Subtask 6.1 – Optimization of Cathode Electrode Formula. This subtask aims to tailor the cathode electrode formula for high power and high energy density UAS applications, by optimizing the ratio of cathode material, electric conductive and binder inside the cathode electrode.

Subtask 6.2 – Optimization of Cathode Electrode Slurry Mixing. This subtask aims to study electrode preparation techniques (mixing, coating, and calendaring) to optimize electronic conductivity networks.

Subtask 6.3 – Optimization of Electrolyte Formula. This subtask aims to optimize electrolyte by blending high temperature Li salt, low freezing point solvent and selected additives to form stable CEI protective layers on cathode electrode surfaces, with the goal of long cycle life, high-rate capability and wide temperature range cell performance.

Task 7 – Fabrication and Evaluation of Prototype Pouch Cells.

This task aims to evaluate the battery performance of the synthesized LCO and NMC cathode materials in large pouch-cells, using the optimized formulations developed in Task 6. This objective is to assess their feasibility for integration into PD's battery fabrication process and potential deployment in customer applications. Pouch cells with capacities >1Ah will be fabricated, employing commercial synthetic graphite as the anode electrode. The same advanced testing protocols and analytical methods established in Task 6 will be applied to characterize cycle life, rate capability, and overall performance, providing critical validation of the materials' scalability and practical application.

2.3 Anticipated Results

The primary outcome of this project will be the development and proof-of-concept demonstration of advanced cathode materials that combine superior technical performance with cost competitiveness. Supporting this effort, a dedicated battery materials qualification and testing lab will be established at PD's facility to ensure synthesized materials meet target requirements. The expected results include: The expected results of this project include: **1)** Purification and production of 20–50 grams of battery-grade nickel and cobalt precursors with impurity levels (Fe <10 ppm) suitable for cathode synthesis; **2)** Fabrication of a minimum of 10 grams of high-quality cathode materials (NMC and LCO) meeting battery-grade standards; **3)** Assembly and testing of >10 coin-type half-cells pairing the synthesized cathodes with lithium metal anodes, demonstrating electrochemical performance superior to commercial reference materials; **4)** Development of 3–5 full NMC or LCO pouch cells achieving ≥ 260 Wh/kg specific energy,

targeting high-power drone applications, and **5)** Completion of a process design for pilot-scale cathode material production (25 tons/year) that validates the technical and economic performance of our innovative process; **6)** Establishment of a fully functional Battery Materials Qualification & Testing Lab at PD's factory in Fargo.

In the next phase, we will conduct a full techno-economic analysis (TEA) and life-cycle assessment (LCA) to evaluate the scalability and environmental impact of the process. A Manufacturing Transition Plan (MTP) will be developed to define the required steps toward commercial manufacturing. Upon project completion, we will be positioned to pursue licensing opportunities and advance toward establishing commercial-scale cathode production in North Dakota.

2.4 Facilities & Resources

UND has world-class facilities and resources that will be leveraged in this project, including: 1) wet-chemistry labs, 2) advanced materials characterization laboratories, 3) bench-scale and pilot-scale facilities associated with UND's development of lignite-based REE technologies, which can be used in the separation and purification of nickel and cobalt from Mixed Hydroxide Precipitate with minimal additional equipment additions, 4) various furnace types and sizes that can be used for production of cathode materials, and 6) commercial license to AspenPlus process simulation software and license for SimaPro LCA software.

Packet Digital LLC operates two well-equipped facilities in Fargo, North Dakota, for power electronics and battery pack design, development, and manufacturing. The headquarters spans 11,161 square feet, featuring offices, collaborative spaces, and a 4,000-square-foot lab with ESD-safe flooring. The production facility covers 25,000 square feet, with 20,000 square feet dedicated to production activities including PCB assembly, battery welding, testing, and final product assembly. Both facilities have advanced security measures. Additionally, Packet Digital recently acquired an 80,000-square-foot warehouse in Fargo, to be converted into a cell manufacturing plant, designed to support and expand their production capabilities.

The project will also leverage the facilities of our industry partners. **Talon Metals** will supply mixed hydroxide precipitates feedstock through their partner the University of Columbia. **Wellspring Hydro** will supply battery-grade lithium carbonate (Li_2CO_3) or lithium hydroxide (LiOH) from their facility at Williston, ND. **Appendix 7** provides additional details about UND's facilities and resources and PD's proposed Battery Materials Qualification & Testing Lab.

2.5 Techniques to Be Used, Their Availability and Capability

A high-level summary of the techniques for the separation and purification of nickel and cobalt, and synthesis of cathode materials were described in Section 2.2 Methodology, more details are included in

the confidentials (**Appendix 2**). These separation and purification techniques are somewhat synergetic with UND's patented REE extraction techniques (U.S. Patent No. US10669610B2, US20220145421A1, and US20220144660A1). The majority of the required techniques and the associated bench-scale and pilot-scale facilities are directly available at UND's REE plant at Grand Forks, with minimal amendment and additional equipment needed. Key techniques for synthesizing cathode materials NMC and LCO are also confidential included in the **Appendix 2**. UND team has intensive experience and patented technologies (U.S. Patent No. 17/558,080) in the synthesis of Li-ion battery cathode materials LiFePO_4 , which was funded by the Renewable Energy Program (R-035-044). The key steps like precursor blending and following solid-phase calcination can be easily adopted to the proposed cathode materials NMC and LCO. All the lab and bench-scale equipment and facilities for this project are directly available without modification.

2.6 Environmental and Economic Impacts while Project is Underway

The proposed work will involve negligible environmental impacts, as the work involves research-scale demonstrations and desktop engineering work. We will follow all UND permits and procedures for effluent management. Economic impacts during the project will primarily involve employment opportunities for UND faculty, staff and students and the workforce development/ training associated therewith. The Battery materials R&D platform establishment at PD's facility will have minimal environmental impact, limited to standard construction, and will comply with all applicable state and federal regulations.

2.7 Ultimate Technological and Economic Impacts

Successful commercialization will have broader technological and economic impacts: **1)** Strengthen PD's capabilities in securing domestic battery supply chain, positioning it as a leader in next-generation Li-ion batteries for UAS applications; **2)** Expand market opportunities for Talon Metals and Wellspring Hydro by creating new customers their feedstocks; **3)** Transform North Dakota's rich critical minerals and renewable energy assets into high-value products, driving national technological leadership; **4)** Stimulate investment, create highly skilled jobs, and foster regional economic development through critical minerals mining, advanced manufacturing, and energy innovation.

2.8 Why the Project is Needed

North Dakota is uniquely positioned to lead in critical minerals, with in-state resources of nickel, cobalt, lithium, and rare earth elements, all . However, the state currently lacks the R&D infrastructure needed to transform these raw materials into battery-grade components that directly support domestic manufacturing. At the same time, Packet Digital's Department of Defense (DoD) clients face urgent requirements for secure and fully domestic supply chains for critical battery materials. Without a local

source of those critical materials, PD's new cell manufacturing facility in Fargo must depend on foreign suppliers, creating risk for defense and drone applications. This project will bridge the gap between North Dakota's mineral resources and PD's manufacturing needs, ensuring that the economic and strategic value of these resources is captured in-state. This effort will also develop a skilled workforce, strengthen regional supply chains, and lay the groundwork for pilot-scale production in North Dakota, directly advancing both state economic diversification and national security priorities.



INDUSTRIAL COMMISSION OF NORTH DAKOTA
RENEWABLE ENERGY PROGRAM

TECHNICAL REVIEWERS' RATING SUMMARY

R-056-B

EMPOWERING THE CRITICAL MINERALS FOR NOVEL CATHODE
MATERIALS-BASED DRONE BATTERIES

Principal Investigator: Xiaodong Hou

Request for \$500,000; Total Project Costs \$1,000,000

TECHNICAL REVIEWERS' RATING SUMMARY					
R-056-B					
EMPOWERING THE CRITICAL MINERALS FOR NOVEL CATHODE MATERIALS-BASED DRONE BATTERIES					
Principal Investigator: Xiaodong Hou					
Request for \$500,000 Total Project Costs \$1,000,000					
Rating Category	Weighting Factor	Technical Reviewer			Average Weighted Score
		1B	2B	3B	
		Rating			
1. Objectives	9	2	4	4	30.00
2. Achievability	9	4	4	4	36.00
3. Methodology	7	4	4	4	28.00
4. Contribution	7	2	3	4	21.00
5. Awareness	5	2	5	4	18.33
6. Background	5	3	4	5	20.00
7. Project Management	2	4	3	4	7.33
8. Equipment Purchase	2	3	5	3	7.33
9. Facilities	2	4	4	5	8.67
10. Budget	2	2	5	4	7.33
Average Weighted Score		147	200	205	184.00
Maximum Weighted Score					250.00

1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Renewable Energy Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 1B (Rating 2)

This proposal is for further research into lithium battery production utilizing raw materials and production in North Dakota. Unfortunately, this project does not promote any of the renewable energy goals or purposes set forth in the NDIC Renewable Energy Council's mission statement.

Reviewer 2B (Rating 4)

The project intends to develop cathode material for L-ION batteries and start a Battery Materials Qualification Lab. This project goals for demonstration of related industrial technologies and processes for the renewable energy industry and applicable adjacent industries meets the NDIC mission statement for the REC. Developing a domestic supply chain for battery components also meets NDIC's mission statement of leveraging ND resources.

Reviewer 3B (Rating 4)

The proposed project work will lead to the development of advanced cathode materials to enable next-generation Li-ion batteries for drone applications. Further, it will establish a totally domestic supply chain that utilizes ND resources to complete the manufacturing of the cathode materials. Battery technology is a critical component of renewable energy systems and allowing for a dedicated domestic supply system will not only benefit North Dakota but is key to the strategic interests of the United States.

- 2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.**

Reviewer 1B (Rating 4)

The timeline is provided in the proposal along with the budget responsibilities. The proposal does not include an anticipated cash flow graphic or table. The cover letter indicates that the requested support be sent to UND and then it will be distributed as warranted.

Reviewer 2B (Rating 4)

With the approach stated in the application, the project planning and timeframe appear to be achievable. The applicant experience and partnership with industry greatly improves the likelihood of success by utilizing lessons learned from past projects at the research and commercial level.

Reviewer 3B (Rating 4)

The proposal outlines the plan for the project team to complete the program. The participation, including financial commitments leads this reviewer to believe the budget and time suggested are sufficient to complete the project.

- 3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.**

Reviewer 1B (Rating 4)

The requester is a major, research university. The proposal outlines in great detail how the research will systematically progress and what the anticipated results should be.

Reviewer 2B (Rating 4)

The process stated for the development of materials and manufacturing is step-by-step and sufficiently detailed to accommodate any unexpected findings/difficulties in each phase of the project. This methodology appears to be well established with the researchers.

Reviewer 3B (Rating 4)

The proposed project will build on existing work to leverage available ND resources to provide a secure domestic supply chain for critical battery technology. Very importantly, it outlines the next steps

leading to a North Dakota based commercial product manufactured in North Dakota using North Dakota resources. Thus, allowing the state to derive significant value added benefits.

4. **The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Renewable Energy Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.**

Reviewer 1B (Rating 2)

The Renewable Energy Council's mission statement is very specific in its goals and purposes as grant priority is to be given to projects that promote renewable energy. To be fair, this project can create a new and essential industry to North Dakota that leaves the United States less dependent on outside sources to produce batteries. It also utilizes a waste product from the oil fields of North Dakota. However, this proposal does not address any of the goals and purposes set forth by the NDIC Renewable Energy Council.

Reviewer 2B (Rating 3)

As stated above in item 1 the project is in alignment with the goals of the NDIC. The contribution to the NDIC/REC goals will also be significant. Developing the know-how and pilot supply chain for locally produced LION battery components is beneficial and needed.

Reviewer 3B (Rating 4)

Battery technology is a critical need in the development of renewable energy opportunities. The meets that objective and is uniquely focused on using ND resources to meet that challenge.

5. **The principal investigator's 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: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.**

Reviewer 1B (Rating 2)

I understand the process and the chemicals listed in this proposal but have not been exposed to the battery manufacturing process. I have not been exposed to this research activity or literature in the past. I am aware that this proposal does not utilize any of North Dakota's renewable energy resources as the rare earth elements are lignite based and the lithium source is derived from waste water produced by the oil field. The origins of the other raw materials required are not cited in this proposal.

Reviewer 2B (Rating 5)

The PI and Co-PI's appear to be aware of current research and commercial activity in the LION battery market. The marketing on "drones" is limiting, but goes well with ND & UND's push to be the UAS nexus.

The applicant has displayed knowledge of available metrics applicable to proposed LION battery project.

Reviewer 3B (Rating 4)

The assembled team includes experts in a range of areas whose combined knowledge of the research area is very good.

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1B (Rating 3)

I have conducted research projects in my professional life and have a master's degree in chemical engineering. The proposed work and methodology appears to be logical and readily followed. However, I found the proposal submitted to be distractive and extremely disappointing coming from major research university. Evidently this proposal was not proofread before submitting it for review. There are grammatical, punctuation, spelling, and capitalization errors throughout this proposal. There is cut & paste redundancy along with numbering errors. Run-on sentences are present on almost every page. Hopefully this is not the new standard of acceptable proposals requesting taxpayer funding.

Reviewer 2B (Rating 4)

The PI and Co-PI's appear to have the proper background for this project, as detailed in their resumes and research activities. Their backgrounds in battery material component production, testing, and material extraction fit well with the project.

Reviewer 3B (Rating 5)

The team assembled includes recognized experts in the various areas required for a successful project.

7. 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: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 1B (Rating 4)

All of these bases have been covered and appear to be well thought out.

Reviewer 2B (Rating 3)

The project contains an adequate schedule with milestones. The financial plan and communication plan are also defined.

Reviewer 3B (Rating 4)

The milestone chart, schedule and plan for communication are very good. I would expect more details on the financial plan and would ask the technical representative for this program to review the details of equipment purchases and budget for the contract to Pocket Digital including the cost of all items purchased under this contract.

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 1B (Rating 3)

The requestor is utilizing existing university equipment. A portion of the industrial partner's financial support is for the purchase of 3 instruments.

Reviewer 2B (Rating 5)

The purchase of equipment is well justified. The project will be extremely difficult to proceed without the on-site equipment. While not be directly purchased with NDIC funds, the project as a whole will be acquiring equipment.

Reviewer 3B (Rating 3)

The items to be purchased are all needed for the proposed work. I would have liked to see a list with the projected cost for each piece of equipment to be purchase.

- 9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.**

Reviewer 1B (Rating 4)

The facilities and equipment described in this proposal appear to be more than adequate to conduct this research.

Reviewer 2B (Rating 4)

No facilities to be purchased. The equipment listed are commercially available.

Reviewer 3B (Rating 5)

The facilities of the assembled team and the added equipment requested are exceptional!

- 10. The proposed budget “value”¹ relative to the outlined work and the financial commitment from other sources² is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)**

Reviewer 1B (Rating 2)

The economics attached to this proposal appear to be calculated backwards. It appears that the applicant (University of North Dakota) required \$1,000,000 for this next step in this research and wanted half of that to come from the state of North Dakota and half to come from the private sector (Packet Digital & Talon Metals) along with some from the University of North Dakota. The breakdown is:

- 1) UND provides \$150k what is labeled cash. However, currency is never delivered to the research table. The support provide to this research project is in the form of the principle investigator’s time (20%) and tuition waivers for graduate students to work on this project. Almost 63% of their contribution is calculated for fringe benefits and other direct & indirect costs. In my experience, this was called contingency or padding when submitting proposals. The university’s contribution would be better described as “in-kind”.
- 2) Talon Metals provides \$20k in material, expertise and shipping. There is no breakdown of each component so it is unknown as to how this amount was derived.
- 3) Packet Digital is the largest industry partner contributing \$330k to this project. Of this, about \$41k is for equipment and to attend a conference. The rest of the support is in the form of fringe benefits and indirect costs, which is almost 88% of their support.
- 4) The NDIC provides \$500k in support of which \$139k is paid to UND for fringe benefits and other direct & indirect costs along with \$131k in wages. The University of North Dakota will use \$225k of this money to pay a subcontractor. The subcontractor cited is Packet Digital who is the main industrial partner of this project (contribution was calculated fringe benefits and indirect costs). The rest (\$5k) is being used for supplies.
- 5) Based off of this cited cash flow I do not believe that 50% of the total project comes from other sources and should not be considered for funding.

Reviewer 2B (Rating 5)

The leveraging of NDIC funds with a motivated private industry will result in a very high value for the State of ND and region, given the location of the resources and knowledge base. The implication of a “local” supply chain will be felt nationally and beyond.

Reviewer 3B (Rating 4)

The project offers significant value to the state. The fact that all commercial partners are participating financially in the program is significant.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 1B

In my opinion, this is a valuable project for the state of North Dakota. If governmental assistance is required for this research to continue, I believe funding should be given. Just not here as it does not meet any of the goals and purposes set forth in the NDIC Renewable Energy Council’s mission statement. Personally, if I didn’t believe this project was so worthwhile, I would have thrown this request out based on how poorly the proposal was written along with the fabricated economic support. The University should care enough about their work and receiving funding that they would put in the effort to assure that their request is not written in such a manner as this one. As presented, sadly, I cannot recommend funding this project.

Reviewer 2B

This is a good project. This project will be positive for the stakeholders and the state. I would have liked the lab be established at UND or the NDSU industrial park so that the funds would be used for long term educational/lab equipment.

Funding is recommended

Reviewer 3B

The proposed project integrates a range of North Dakota resources to achieve a fully domestic supply chain for critically needed battery technology. Very importantly, it not only defines the technical path to successfully developing the technology. It includes plans for the next steps that would lead to an operation in North Dakota that would allow the state to gain significant financial benefit.

I strongly recommend funding with the caveat that the technical advisor verify the details in the financial plan identified