



Critical Challenges. Practical Solutions.

Energy & Environmental Research Center (EERC)

# BAKKEN PRODUCTION OPTIMIZATION PROGRAM (BPOP) UPDATE

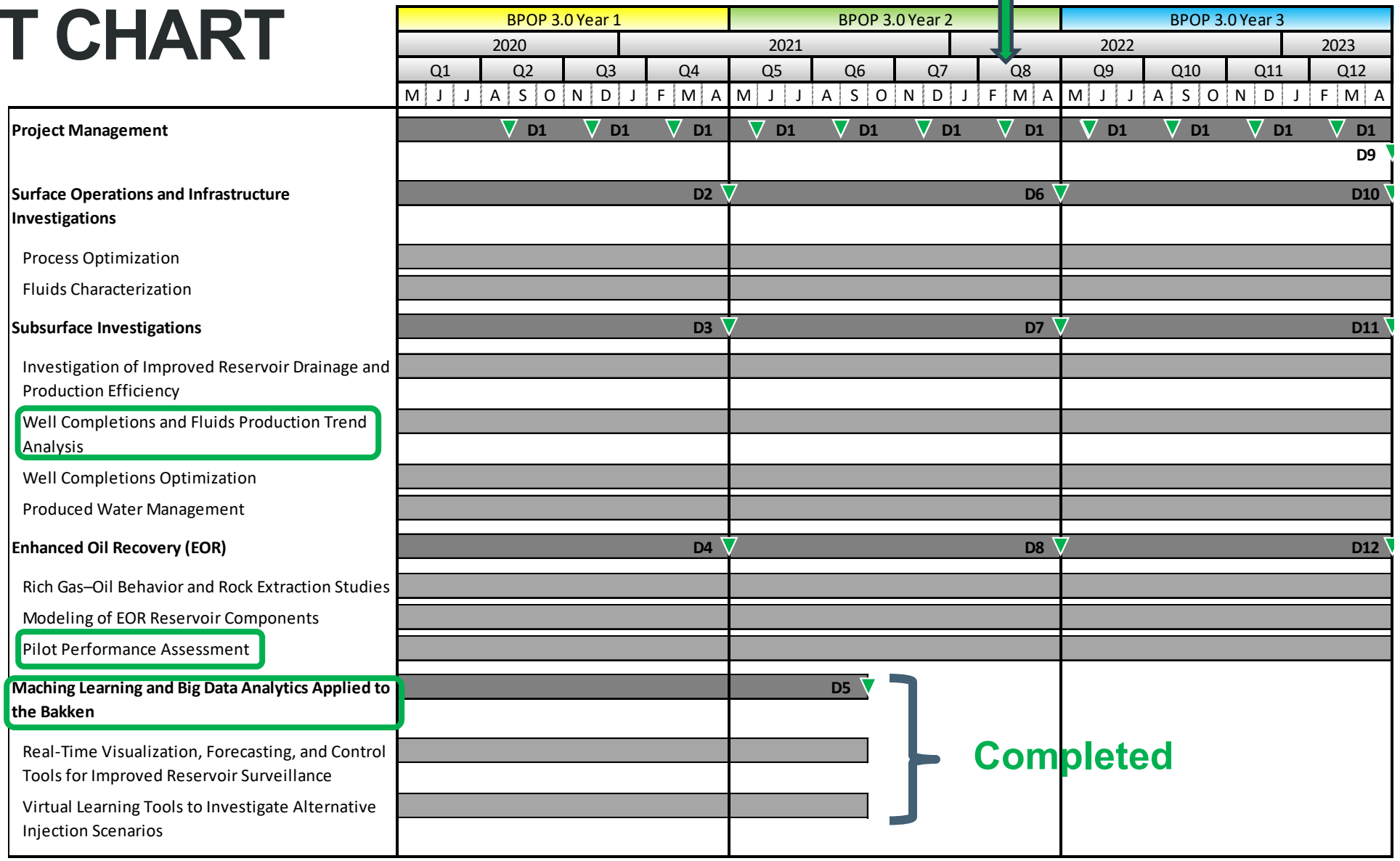
Presented to the North Dakota Oil & Gas Research Council
February 23, 2022

Jim Sorensen
Director of Subsurface R&D

# Outline

- Gantt chart – Activities & Timeline
- Update on Liberty Resources' Rich Gas EOR Pilot at East Nesson
- Machine Learning & Artificial Intelligence Highlights
  - Geologic Cluster Analysis Tool
  - 3-Mile Lateral Study
- Financial Status

# GANTT CHART




D1 – Quarterly Report

D2–D4, D5–D8, D10–D12 – Topical Report

D9 – Final Report

# BPOP PARTNERS

ConocoPhillips

devon

HESS

LIBERTY RESOURCES

Marathon Oil

OASIS PETROLEUM

PETRO - HUNT, L.L.C.

XTO ENERGY

North Dakota oil & gas research program

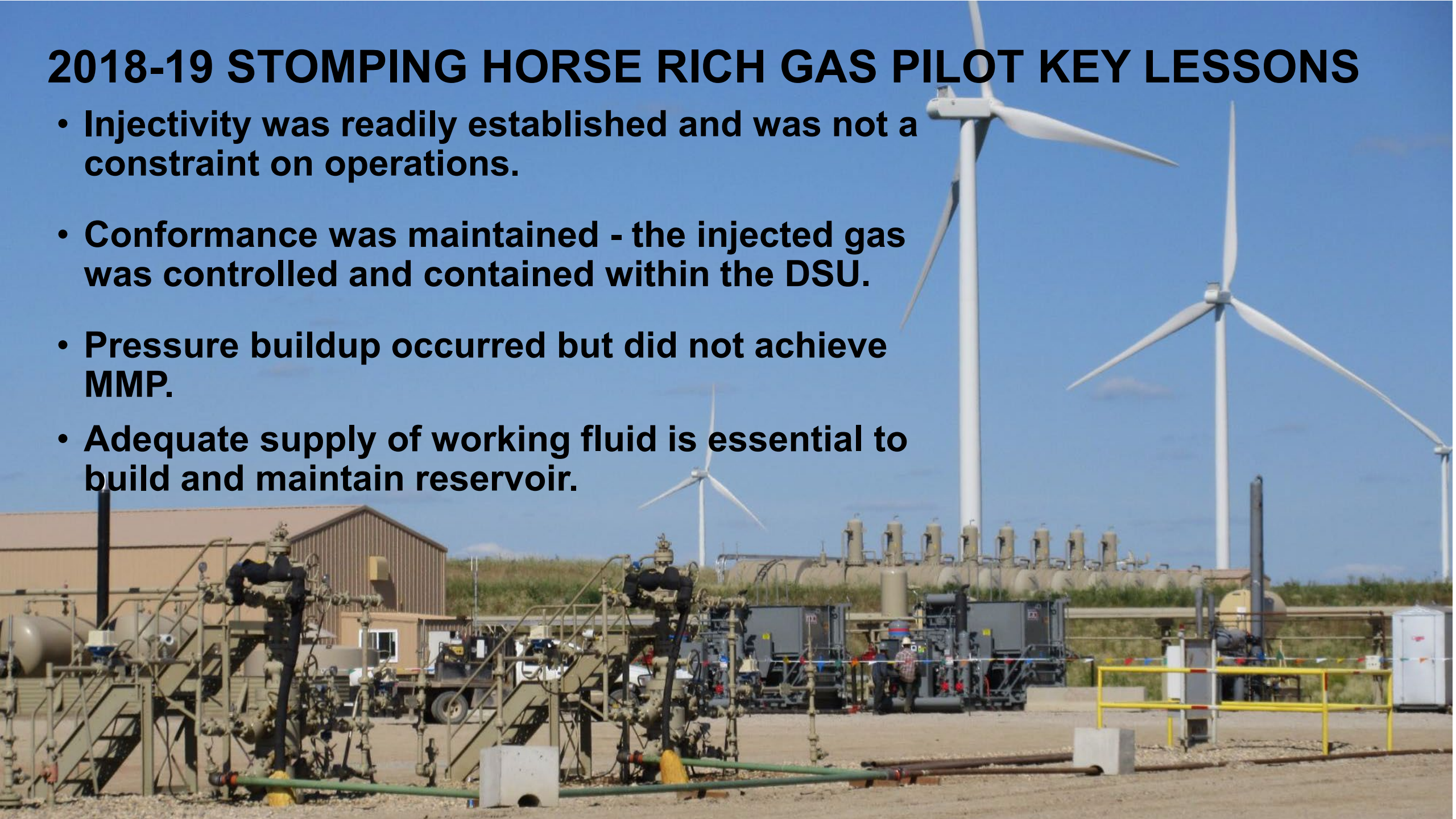
U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

NORTH DAKOTA OIL AND GAS DIVISION

NORTH DAKOTA PETROLEUM COUNCIL

# 2018-19 STOMPING HORSE RICH GAS PILOT KEY LESSONS

- Injectivity was readily established and was not a constraint on operations.
- Conformance was maintained - the injected gas was controlled and contained within the DSU.
- Pressure buildup occurred but did not achieve MMP.
- Adequate supply of working fluid is essential to build and maintain reservoir.



# 2021-22 EAST NESSON PROJECT HYPOTHESIS AND GOALS

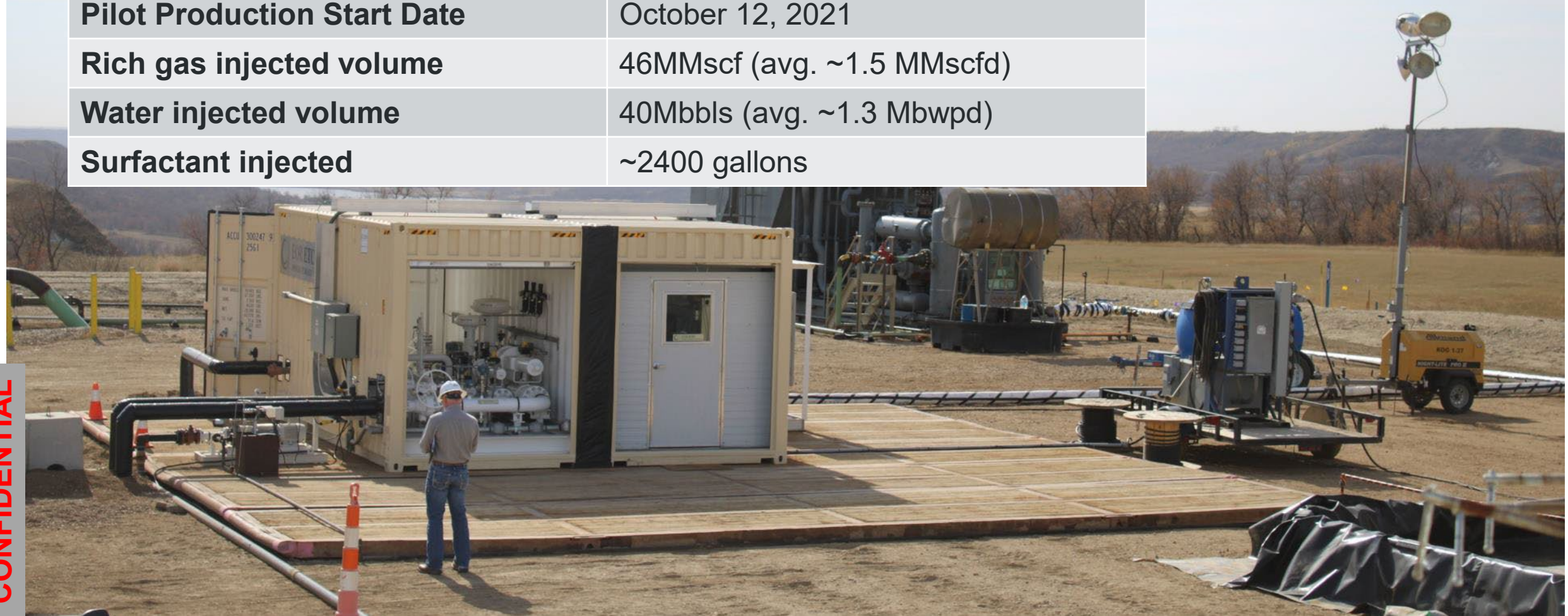
- **Hypotheses:**
  - ❑ Co-injection of gas and water can increase pressure beyond MMP and help improve conformance and containment in the Bakken.
  - ❑ Co-injection process can lower injection pressure needed and associated cost.
- **The main goal and objective**:
  - ❑ to demonstrate the economic viability of enhanced oil recovery from the Bakken Petroleum System by using produced rich gas in combination with water and surfactants.

# EAST NESSON CO-INJECTION TECHNOLOGY IMPLEMENTED

- A novel Enhanced Oil Recovery (EOR) injection technology developed by EOR ETC.
- This technology is commonly referred to as co-injection but is formally called the Rapid-Switched, Stacked-Slug (RSSS) system.
- The RSSS system differs from conventional Water Alternating Gas (WAG) injection techniques by rapidly (in seconds and minutes) switching between liquid and gas injection to create a stacked slug flow regime in the injection path.
- A patent filing was submitted early 2021.

# EAST NESSON EOR PILOT IMPLEMENTATION

| | |
|---|---|
| **Pilot Injection Start Date** | September 10, 2021 |
| **Pilot Injection End Date** | October 11, 2021 |
| **Number of cycle** | 1 |
| **Pilot Production Start Date** | October 12, 2021 |
| **Rich gas injected volume** | 46MMscf (avg. ~1.5 MMscfd) |
| **Water injected volume** | 40Mbbls (avg. ~1.3 Mbwpd) |
| **Surfactant injected** | ~2400 gallons |



# EAST NESSON EOR PILOT OPERATIONAL PRESSURES

| | |
|---|---|
| **Initial Bottomhole Pressure** | ~1000 psi |
| **Est. Minimum Miscibility Pressure (MMP)** | ~2430 psi |
| **Max. Wellhead Pressure (measured)** | ~1300 psi |
| **Max. Bottomhole Pressure (calculated)** | ~4450 psi |

# KEY OBSERVATIONS FROM EAST NESSON INJECTION CYCLE

- Injectivity was readily established.
- High pressure buildup occurred and was maintained with the co-injection, far beyond MMP.
- The lower wellhead injection pressure under 1300 psi was maintained by the co-injection.
- A minor gas breakthrough at one of the adjacent wells was observed but was able to be controlled and contained by increasing the water slug ratios to the well.

# EAST NESSON PRODUCTION CYCLE IS ONGOING…

# ACKNOWLEDGEMENT: EAST NESSON PROJECT PARTNERS


- Liberty Resources Management
- EOR ETC
- CMG
- TAMU (Dr. David Schechter)


# AI & ML FOR EOR IN THE BAKKEN – 2021 HIGHLIGHTS

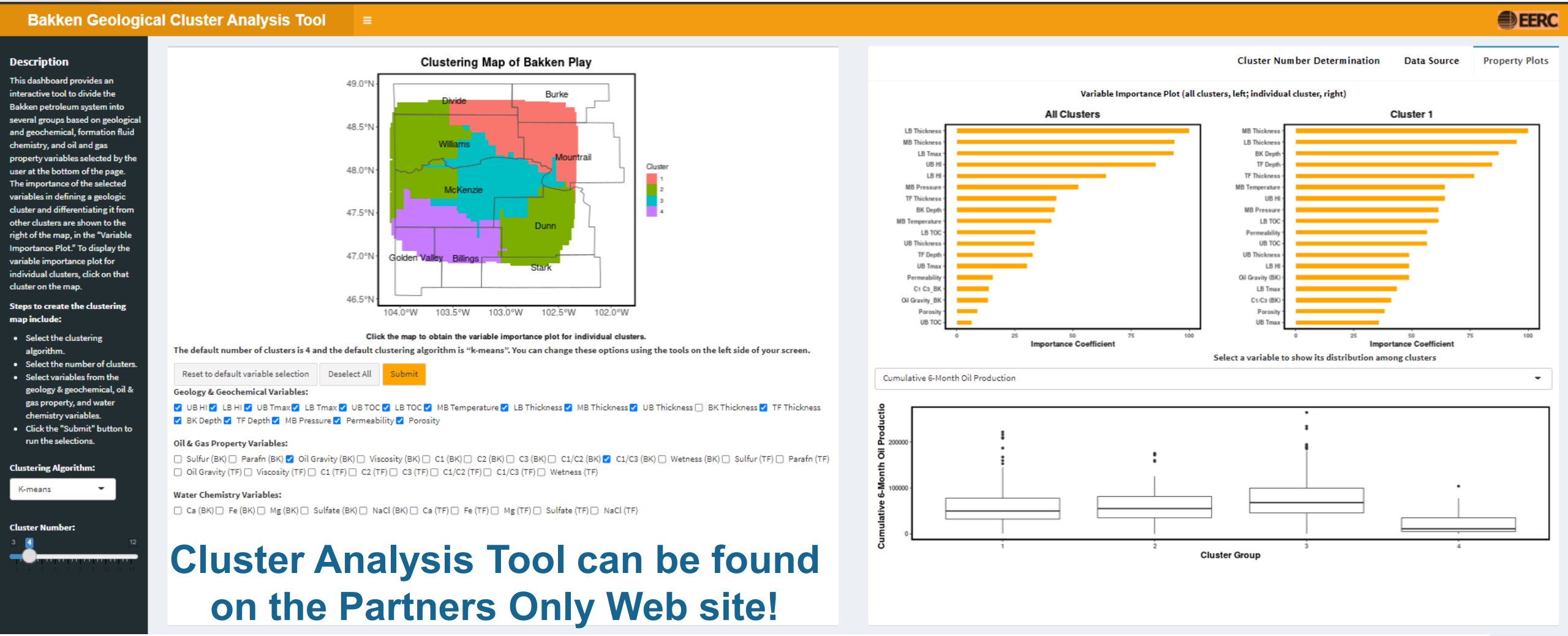
***Artificial Intelligence & Machine Learning for Unconventional EOR Strategies*** *– Created algorithms informing reservoir performance predictions based on injection rate versus soak time, production time, and injection time.*

- *Created a tool to perform Real time visualization and forecasting intended to support real time decision making during production operations.*

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

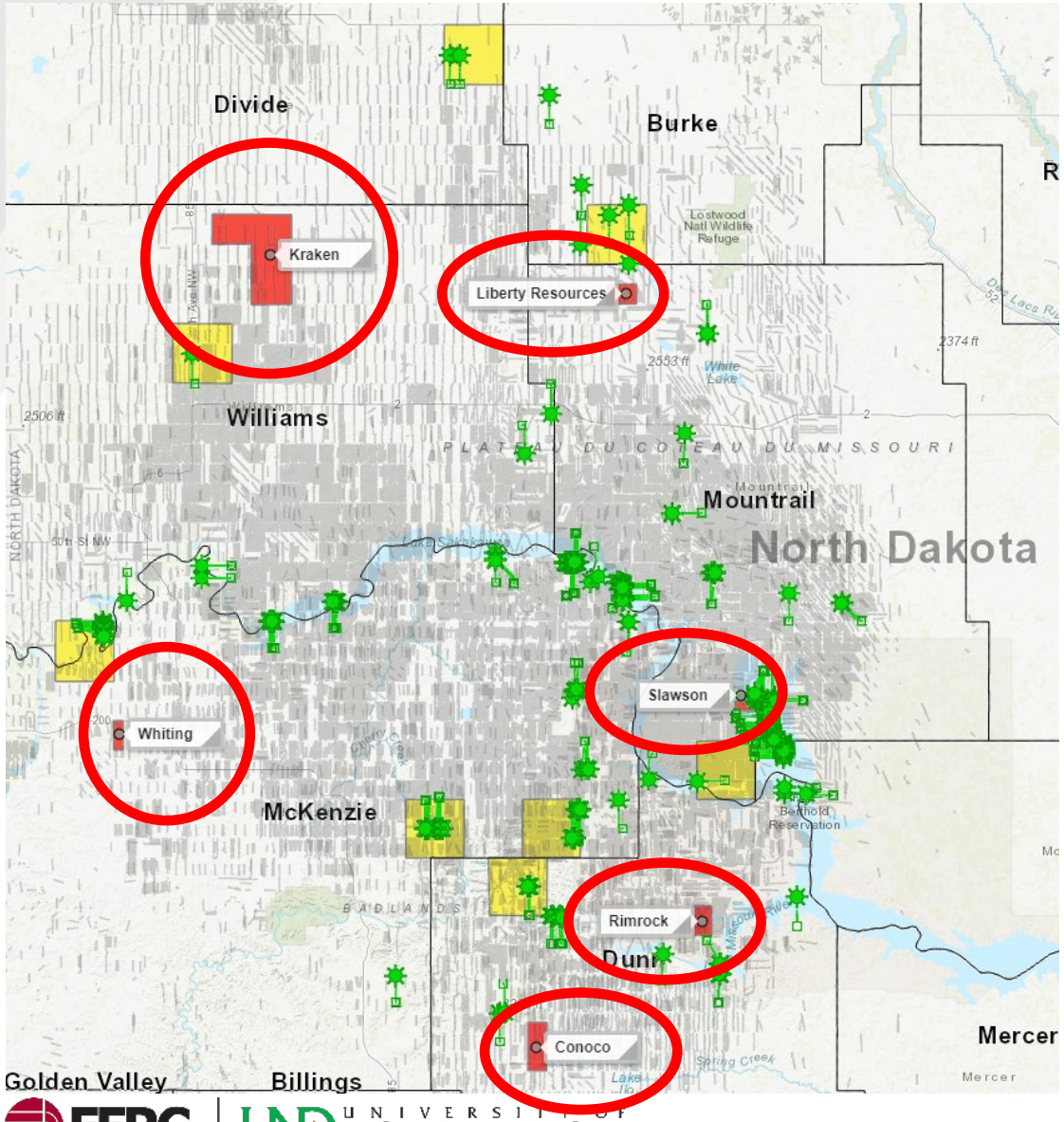
- Embedded Discrete Fracture Modeling (EDFM) shown to improve simulation run times and demonstrated excellent results matching fluid injection and production data.
- ***Modeling & simulation studies showed conformance can be gained through the use of water injection or surfactant injection and demonstrated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

# WEBINAR TOPIC – GEOLOGIC CLUSTER ANALYSIS TOOL




**Cluster Analysis Tool can be found on the Partners Only Web site!**

# WEBINAR TOPIC - STUDY OF 3-MILE LATERALS




Beginning to see development plans outside of geographic constraints that are designed to accommodate 3-mile horizontal wells.

Development characteristics:

26% - Average additional capital to drill and complete a 3-mile lateral.

20%-50% - Expected increase in EUR

Anticipated increased returns

Fewer facilities, improved costs

Less surface impact

Stand-ups producing better than laydowns

# FINANCIALS

| Sponsors | Original Budget | Secured to Date |
|---|---|---|
| NDIC Share – Cash | $6,000,000 | $6,000,000 |
| Industry Share – Cash | $500,000 | $800,000 |
| DOE – Cash | $1,500,000 | $1,500,000 |
| Liberty – In-Kind | $4,000,000 | $1,449,684 |
| Oasis – In-Kind | | $2,109,144 |
| EOR ETC – In-Kind | | $110,000 |
| CMG – In-Kind | | $28,500 |
| Balance – TBD | | $2,672 |
| Total | $12,000,000 | $12,000,000 |

**Jim Sorensen**
**Director of Subsurface R&D**
jsorensen@undeerc.org
701.777.5287 (phone)

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

www.undeerc.org
701.777.5000 (phone)
701.777.5181 (fax)

# THANK YOU

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