UNITIZATION AND ENHANCED RECOVERY TECHNIQUES

ND State Legislature
Interim Taxation Committee
Bismarck, ND
April 27, 2016
Unitization and Enhanced Oil Recovery

• Unitization Process
• Units Approved
• EOR Results
• Bakken Development
• Bakken EOR Potential

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Welcome to the North Dakota Industrial Commission, Department of Mineral Resources, Oil and Gas Division, home page!

Please check out the new Information Center and Pollution Prevention Program.

Proposed Rule Changes and Adoption of New Rules

Rule Changes Full Notice

General Guidelines for Temporary Abandonment of Wells

Bakken and Three Forks Information!

Available on the ND Petroleum Council website are the Surface Owner Information Center, the Royalty Owners' Information Center, and the Employment Opportunities Program.

The Oil and Gas Division regulates the drilling and production of oil and gas in North Dakota. Our mission is to encourage and promote the development, production, and utilization of oil and gas in the state in such a manner as will prevent waste, maximize economic recovery, and fully protect the correlative rights of all owners to the end that the landowners, the royalty owners, the producers, and the general public realize the greatest possible good from these vital natural resources.
The Director's Cut is an update on current activity in the North Dakota oil patch from the Director of the Department of Mineral Resources.

Tentative Director's Cut Dates

Director's Cut - 02/17/2016
Director's Cut Archive
Director's Cut Webinars

Recent Presentations

View press releases from the Oil and Gas Division

Oil and Gas Division Program Descriptions:
This section of the Information Center is dedicated to program descriptions within the Oil and Gas Division. We will be adding descriptions as they become available, so check back for further information.

Underground Injection Control Program
Unitization and Enhanced Oil Recovery

• Unitization Process
• Units Approved
• EOR Techniques & Results
• Bakken Development
• Bakken EOR Potential
Unitization Process

NDCC Sec 38-08-09.3

- Project substantially increases oil recovery
- EOR unnecessary for approval
- Voluntary and Statutory Units
  - both require Commission approval
Unitization—Statutory Approval

NDCC Sec 38-08-09.5

- 60% mineral interest owner approval
- 60% working interest owner approval
- NDIC approval
Unitization and Enhanced Oil Recovery

- Unitization Process
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Units Approved

• 127 Units approved
  – 124 EOR w/ fluid injection
    • Most water injection
    • high pressure air (8)—fire flood
    • also propane, CO$_2$, polymers, N$_2$, + other fluids
  – 3 created to increase reserves w/o injection
    • Little Missouri-Pierre Unit—shallow gas reservoir
    • Cedar Creek-Pierre Unit—shallow gas reservoir
    • Corral Creek-Bakken Unit
Bakken Units

• Corral Creek-Bakken Unit
  – Effective 1-1-2012
  – 30,884 acres
  – increased reserves over 5 million barrels of oil
  – 81 wells originally planned
  – 122 wells drilled currently
  – 194 wells currently planned
  – EOR not planned initially
    • EOR only after due notice and hearing

• Grail-Bakken Unit
  – 24,947 acres
  – failed to achieve 60% MIO approval
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Unitization and Enhanced Oil Recovery

- **Conventional Oil Reservoir**
  - Primary 15% recovery
  - Secondary add 15% recovery
  - Tertiary add 10% recovery
  - 40% recovery of Original Oil in Place (OOIP)

- **Unconventional Oil Reservoir**
  - Bakken-Three Forks Formations
  - 3% Primary recovery / well
  - Secondary & Tertiary recovery?
AIR INJECTION PROCESS

BURNING FRONT

HOT WTR & CO₂

PROD

OIL
Cedar Hills South Red River B Unit

Conventional Oil Reservoir
88 original wells (1H/640)
316 million barrels OOIP
Primary: 8% recovery of OOIP
26 million bo
wells not fraced
Cedar Hills South Red River B Unit

EOR initiated
Cedar Hills South Red River B Unit

Incremental Oil Determination
- establish historical decline
- project baseline decline w/o EOR
- calculate oil above the base

Cedar Hills South-RR ”B” Unit
- EUR w/o EOR = 26 mil bo
- current Incremental = 74 mil bo
- current oil cum = 101 mil bo
Unitization and Enhanced Oil Recovery

- Unitization Process
- Units Approved
- EOR Techniques & Results
- Bakken Development—encourages EOR
  - Uniform Spacing—orderly development
  - Energy Corridors
- Bakken EOR Potential
Six Wells on a Single Pad

Vern Whitten Photography
Well density is the big question.

Source: Continental Resources

Bakken Fm

Three Forks Fm

1,320’ & 660’ Pilot Density Projects: 2013-14

Hawkinson, Tangsrud, and Rollefstad

1,320’ Pilot

Wahpeton, Lawrence, Mack, and Hartman

660’ Pilot

- 3 project areas
- 1,320 ft. same-zone spacing
- 34 new wells (gross)

- 4 project areas
- 660 ft. same-zone spacing
- 31 new wells (gross)
Current drilling activity is focused in Mountrail, Dunn, McKenzie, and Williams Counties.
First 60 Day Average Bakken Horizontal Production by Well
July 2015

EXPLANATION
- > 1000 barrels per day
- 500 - 1000 barrels per day
- 250 - 500 barrels per day
- 125 - 250 barrels per day
- 50 - 125 barrels per day
- < 50 barrels per day

Oil Production Averaged Over the First 60 Days of Production
Current drilling activity is focused in Mountrail, Dunn, McKenzie, and Williams Counties.
907 non-completed wells (Feb 2016)
2009 → 8-10 wells / yr / rig
2016 → 20-24 wells / yr / rig
WELLS

• 13,012 wells producing (Feb 2016)
  • 10,898 Bakken (84%)
• 40,000 additional development wells
  • 100 rigs – another 20 years
• Bakken Pool: 4 targets = more wells
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Bakken/Three Forks EOR Potential

• Pilot projects
  – CO₂ injection
  – water injection
  – projects small-scale and usually inconclusive
  – further testing must be conducted

• > 300 billion barrels OOIP
  – every 1% of EOR = 3 billion barrels
  (note: cum oil prod from 1951-2015 = 3.3 bil bo)
Reclaimed Location