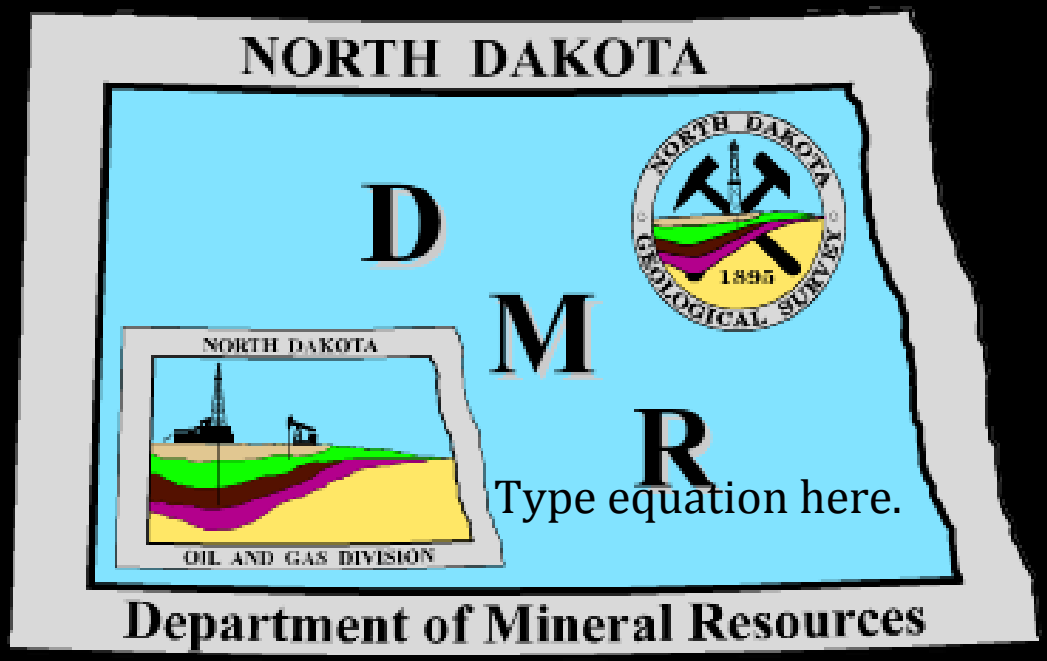
North Dakota Department of Mineral Resources



Type equation here.

http://www.oilgas.nd.gov

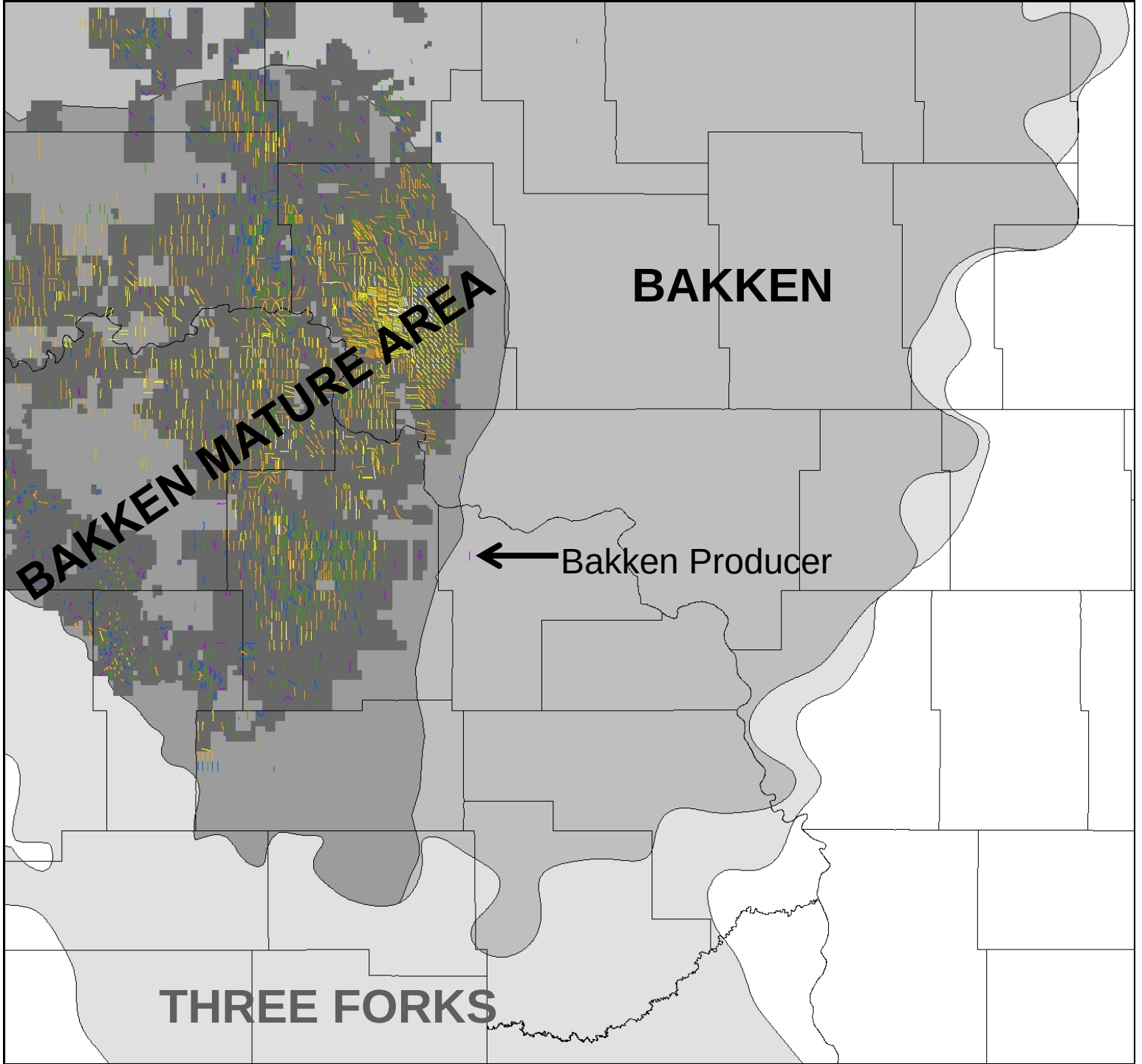
http://www.state.nd.us/ndgs

600 East Boulevard Ave. - Dept 405
Bismarck, ND 58505-0840
(701) 328-8020 (701) 328-8000

BAKKEN BASICS

- Where are we?
- Where are we going?
- How did we get here?
- What could change?

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011


BAKKEN
BAKKEN MATURE AREA
Bakken Producer
THREE FORKS

BAKKEN BASICS:
WHERE ARE WE?

NO ONE TRICK PONY

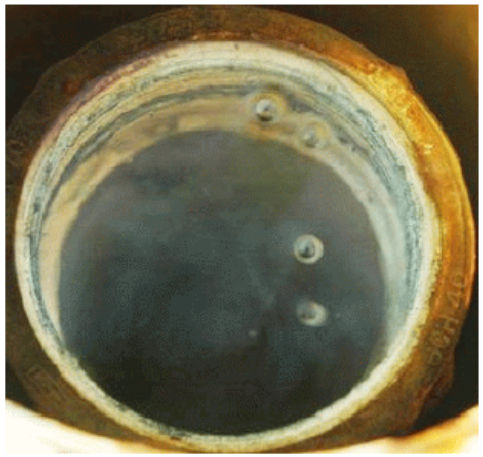
- **Tyler = est. 2500 wells**
  - **SW North Dakota**
- **Spearfish = est. 2500 wells**
  - **Bottineau County**
- **Red River= est. 100 wells**
  - **Golden Valley, Bowman Counties**
- **Mission Cannon = unclear at this point**
  - **Burke, Renville Counties**

SHALLOW GAS PROJECT

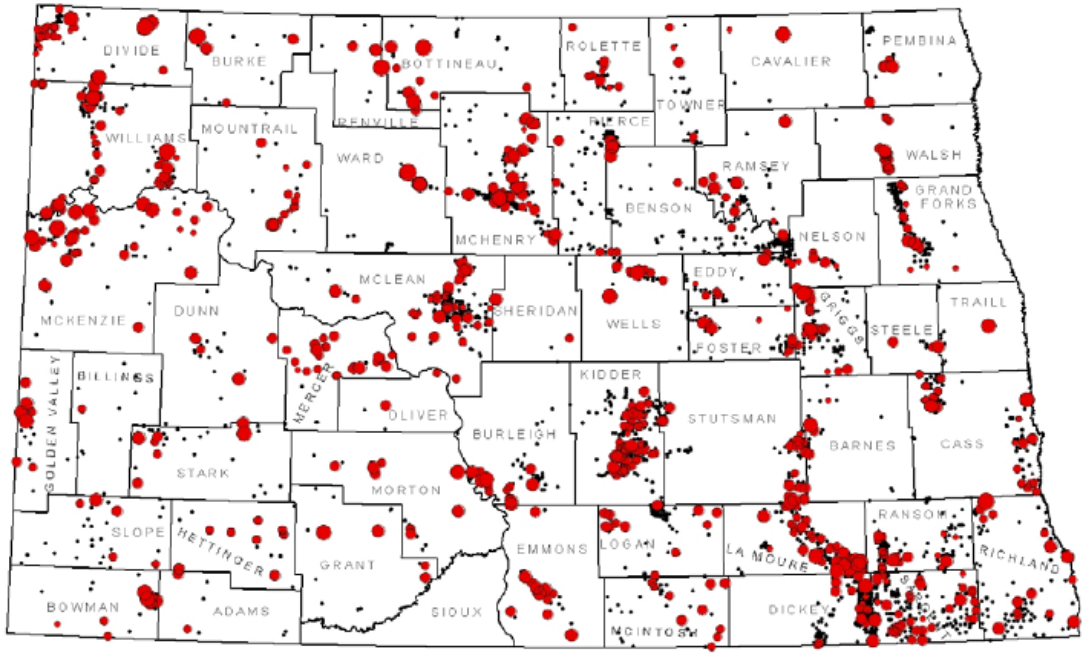
The Geological Survey tested 4,325 NDSWC monitoring wells for methane in 52 of the 53 counties in North Dakota from 2006-2010.

The Geological Survey recently completed phase I of a study of shallow natural gas in North Dakota. We investigated 9,400 ND State Water Commission monitoring well sites, tested 4,325 wells, and detected methane in 905 wells. Approximately 20% of the wells contained detectable gas.

During the second phase of the project, thirty groundwater samples, primarily from eastern North Dakota, will be analyzed for dissolved gas composition, isotopes, and general chemistry. This will enable us to determine the source of the gas and identify chemical groundwater signatures that might assist the oil and gas industry in natural gas exploration.

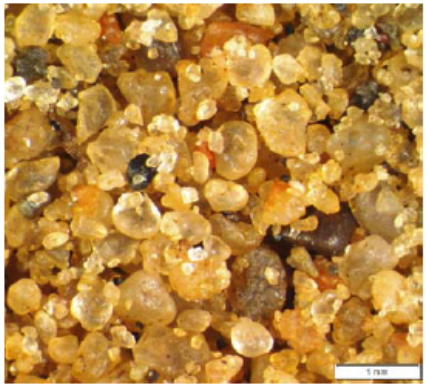


Methane bubbling to the surface in a two-inch NDSWC monitoring well.



Monitoring wells that contained methane are indicated with red dots, black dots are wells that contained no detectable methane. The red dots are sized to reflect the concentration of methane -- the higher the concentration, the larger the dot.

PROPPANT PROJECT

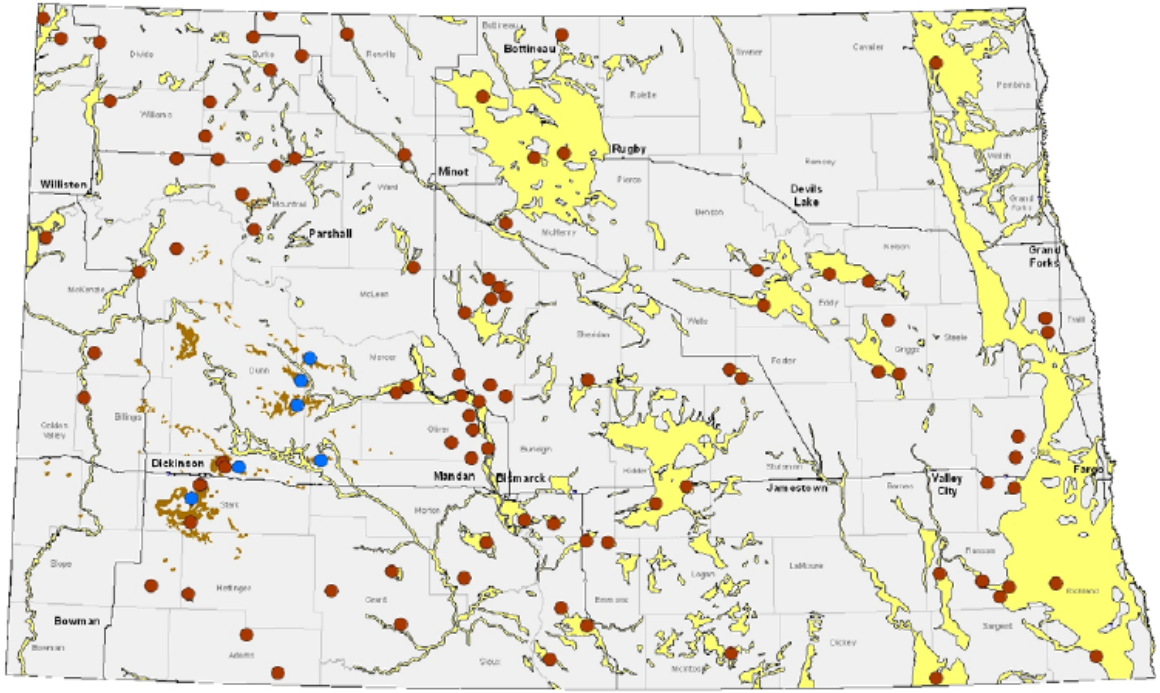


Photomicrograph of sand grains collected in McHenry County.

Photomicrograph of ceramic proppant from a batch that was used in a Bakken well in North Dakota. This proppant was manufactured in China.

Millions of tons of sand and ceramic proppants are used every year in the Williston Basin, part of a multi-billion dollar industry. The Geological Survey has collected 125 sand samples throughout the state in our search for deposits that could be utilized for oil and gas proppants in the well fracing process. We are in the process of performing preliminary analysis on those samples to determine if any would fit the proppant criteria. We have also collected clay samples and will be testing those samples for their kaolin content to determine their suitability in the manufacturing of ceramic proppants.

Under the second phase of this project, the ten most promising sand samples will undergo full ISO analysis (including bulk density, specific gravity, crush resistance, etc), mineralogy (XRD), and stack conductivity analysis to determine which are the most suitable proppant candidates and we will continue to evaluate the clay beds.



Locations of sand samples (red dots) and clay samples (blue dots) collected during this study. The areas in yellow are known sand deposits and the areas in brown are kaolinitic claystones within the Golden Valley Formation.

Estimate 20-50 billion tons of ND Mineable Reserves

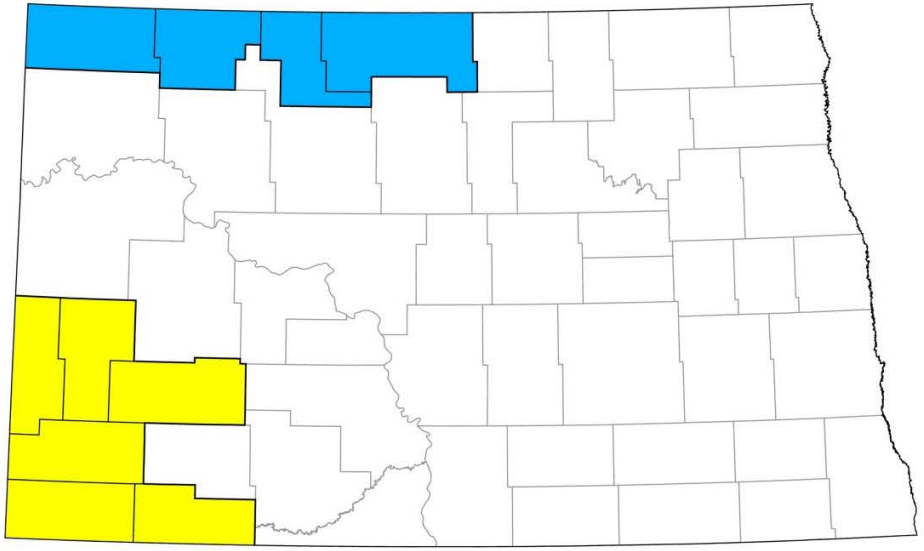
$6 trillion -15 trillion

Potash core from a depth of 9,000 feet in Burke County.

We have received a number of enquires from the mineral industry in the past 18 months as the price increased for a variety of elements and minerals. Chief among these enquiries has been uranium and potash. Uranium was mined in North Dakota in the 1960s. It was heavily explored for in the 1970s, but has been of little interest for the last 30 years until the price for uranium oxide reached an all time high in June of 2007. Companies have also expressed interest in associated elements molybdenum and germanium. We are aware of three companies that are contemplating mining uranium in southwestern North Dakota.

Potash or potassium salts are primarily used in the production of fertilizer. Potash exploration took place in northwest North Dakota in the 1970s. Since 2006, the price of potash rose from $190 to $1,050 per ton then fell to $300 per ton and is rising again. Based on increasing demand in rice growing regions. There are two companies that we know are actively pursuing potash exploitation.

Formation Resources drilling for uranium, molybedenum, and germanium under a subsurface mineral permit in Billings County during the fall of 2008.



Counties that contain uranium deposits are in yellow and those that contain the shallowest potash deposits are in blue.

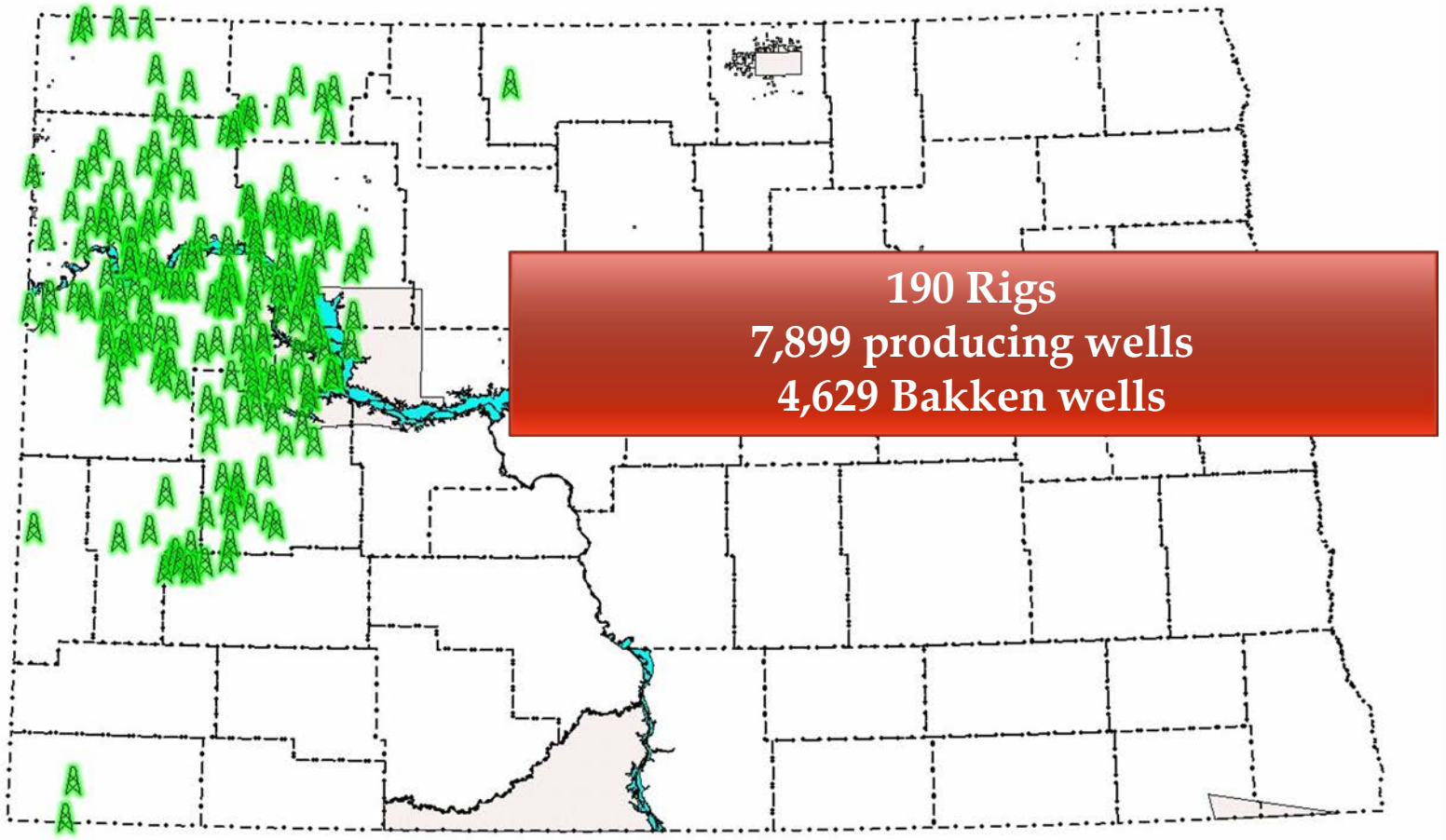
BAKKEN BASICS:
WHERE ARE WE?

- **Became #3 Oil Producing state in March**
  (January figures)
- **Became #2 Oil Producing state in May**
  (March Figures)
- **September production 21.8 million barrels of oil or 728,000 barrels of oil per day**
- **23.8 Billion cubic feet of natural gas or 793 million cubic feet per day**

BAKKEN BASICS:
WHERE ARE WE?

- **2 Billionth barrel of oil produced in November 2011**
- **1 Billionth barrel of oil produced in October 1989**
- **First barrel of oil produced in April 1951**

BAKKEN BASICS:
WHERE ARE WE?



BAKKEN BASICS:
WHERE ARE WE?

What Does Every New Bakken Well Mean to North Dakota

A typical 2012 North Dakota Bakken well will produce for 45 years

If economic, enhanced oil recovery efforts can extend the life of the well

In those 45 years the average Bakken well:

Produces approximately 615,000 barrels of oil

Generates about $20 million net profit

Pays approximately $4,325,000 in taxes
- $2,100,000 gross production taxes
- $1,800,000 extraction tax
- $425,000 sales tax

Pays royalties of $7,300,000 to mineral owners

Pays salaries and wages of $2,125,000

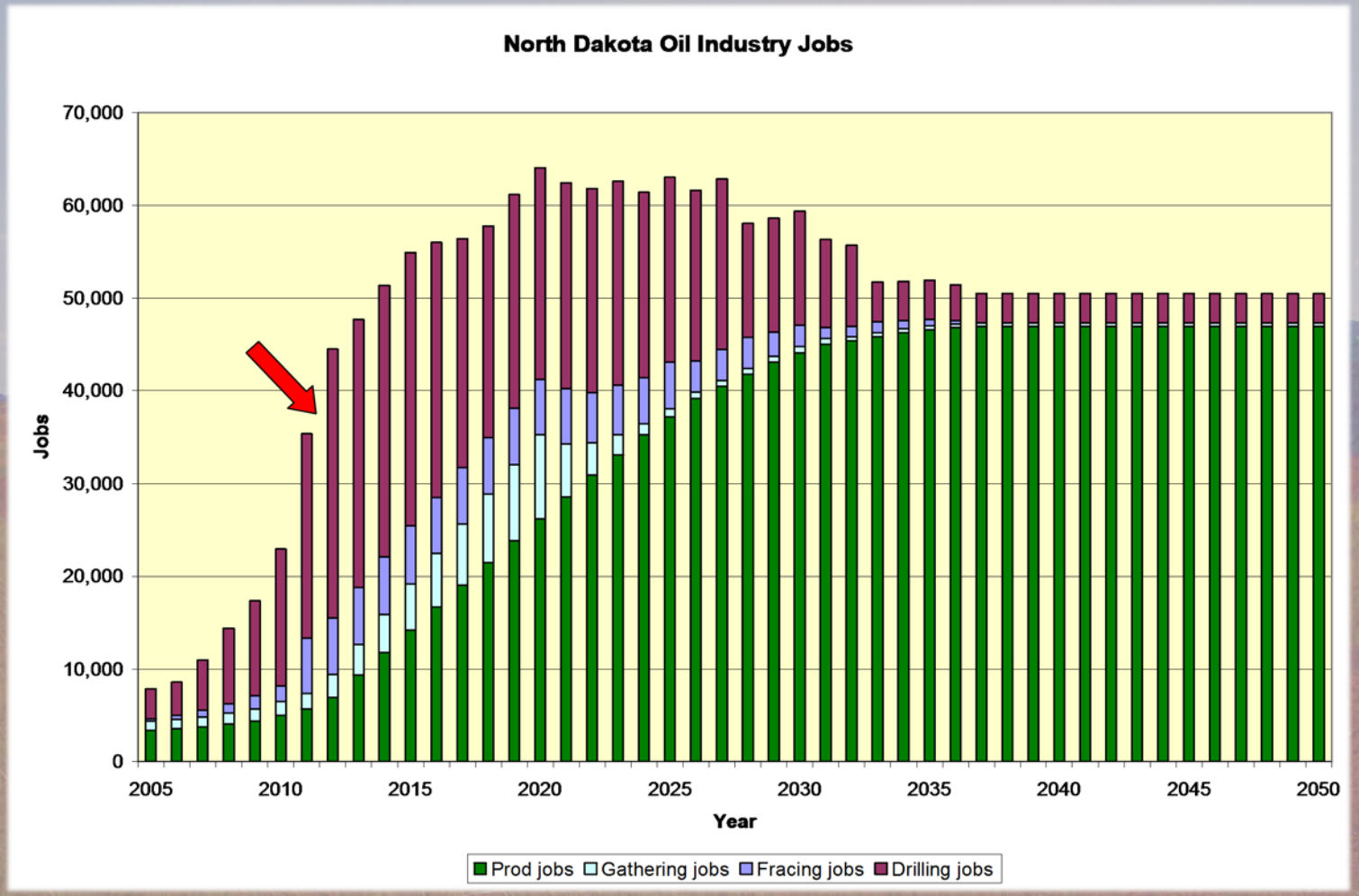
Pays operating expenses of $2,300,000

Cost $9,000,000 to drill and complete

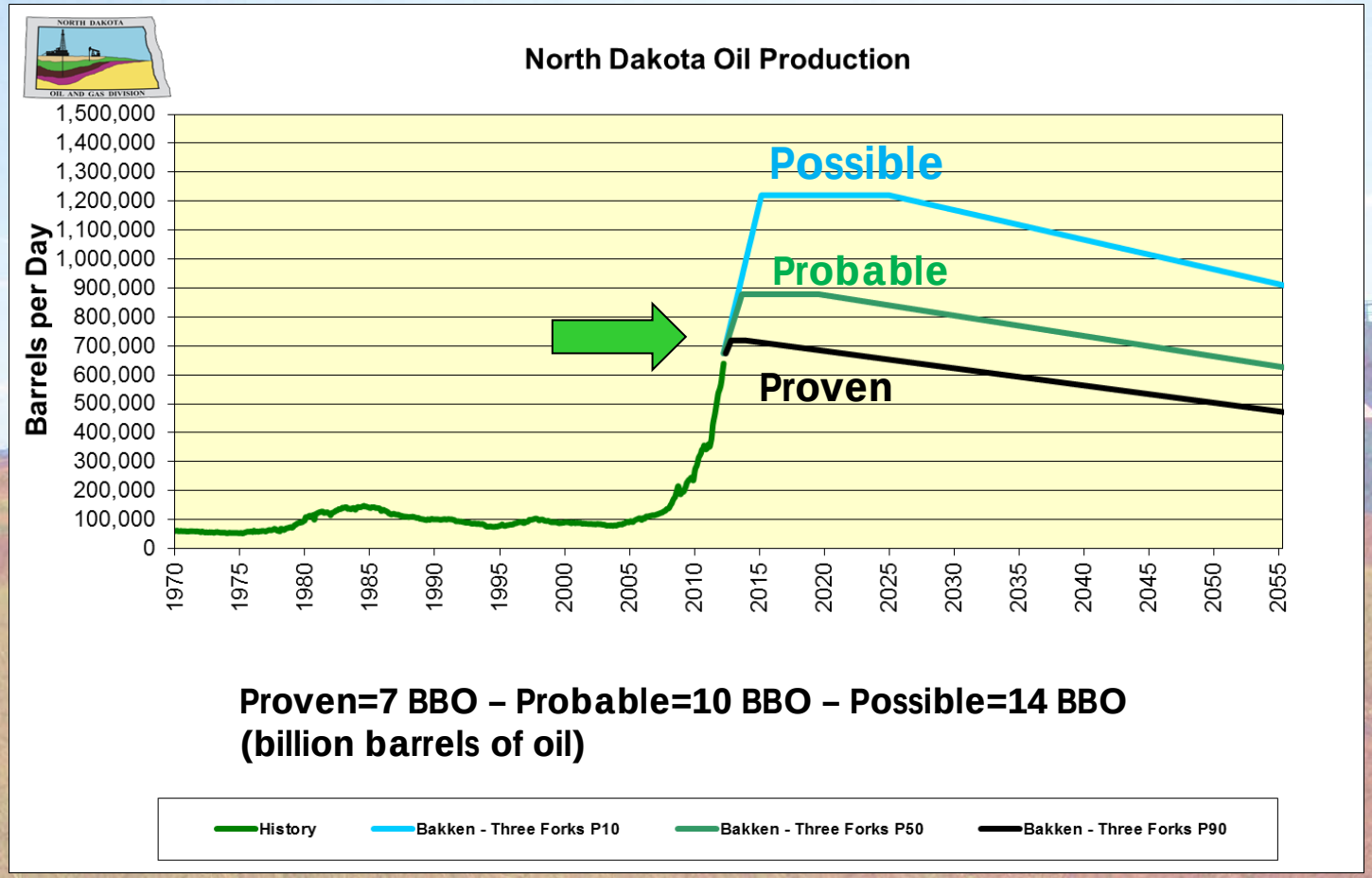
BAKKEN BASICS:
WHERE ARE WE GOING?

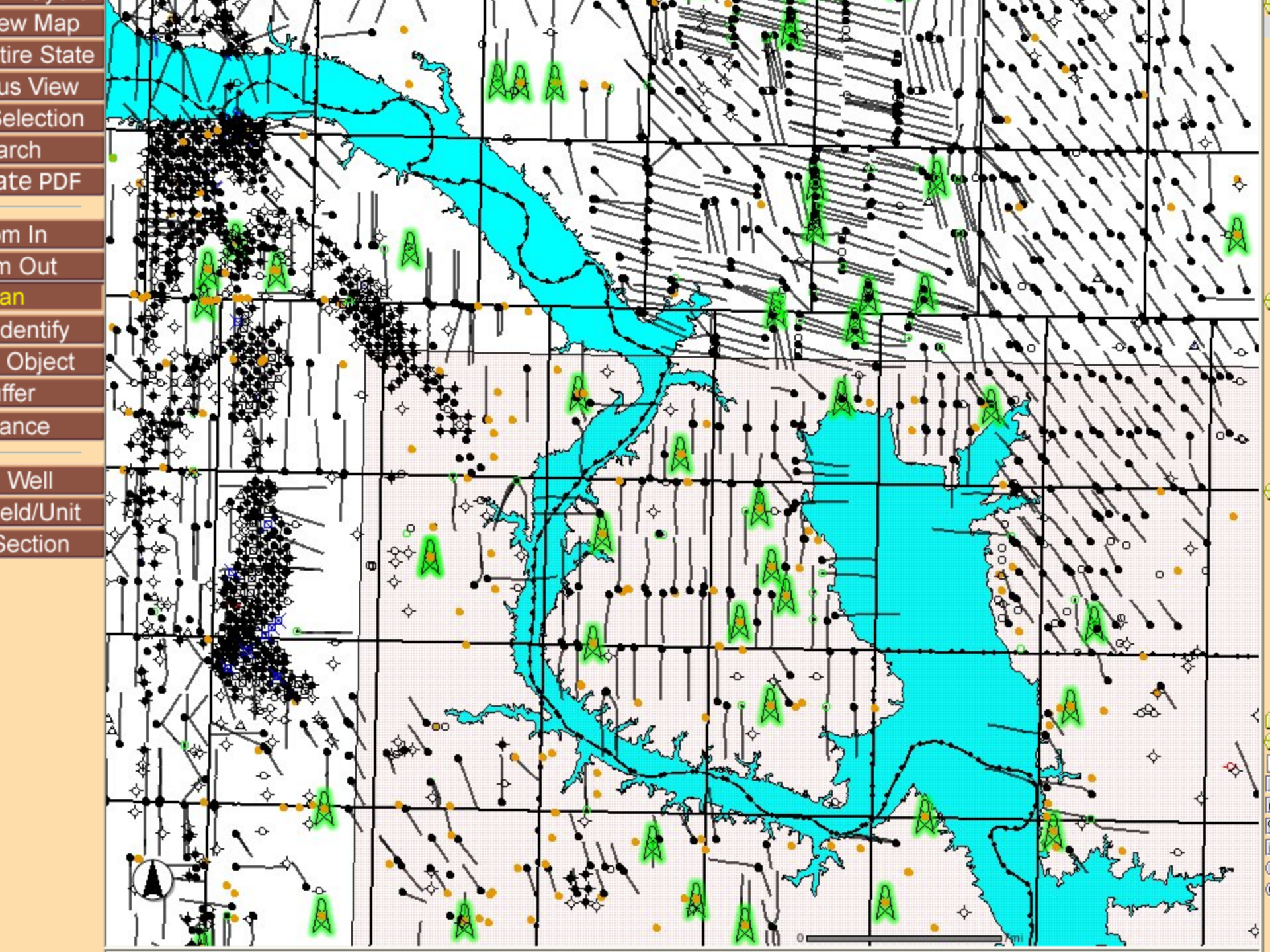
- **1,800 to 3,000 wells/year = 2,000 expected**
  - **150-250 rigs = 12,000 – 30,000 jobs**
  - **Another 10,000-15,000 jobs building infrastructure**
  - **200 rigs can drill the wells needed to secure leases in 1 year**
  - **200 rigs can drill the wells needed to develop spacing units in 18 years**
  - **35,000-40,000 more new wells**

BAKKEN BASICS:
WHERE ARE WE GOING?



BAKKEN BASICS:
WHERE ARE WE GOING?

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https://www.dmr.nd.gov/OaGIMS/viewer.htm

Oil and Gas : ArcIMS Viewer

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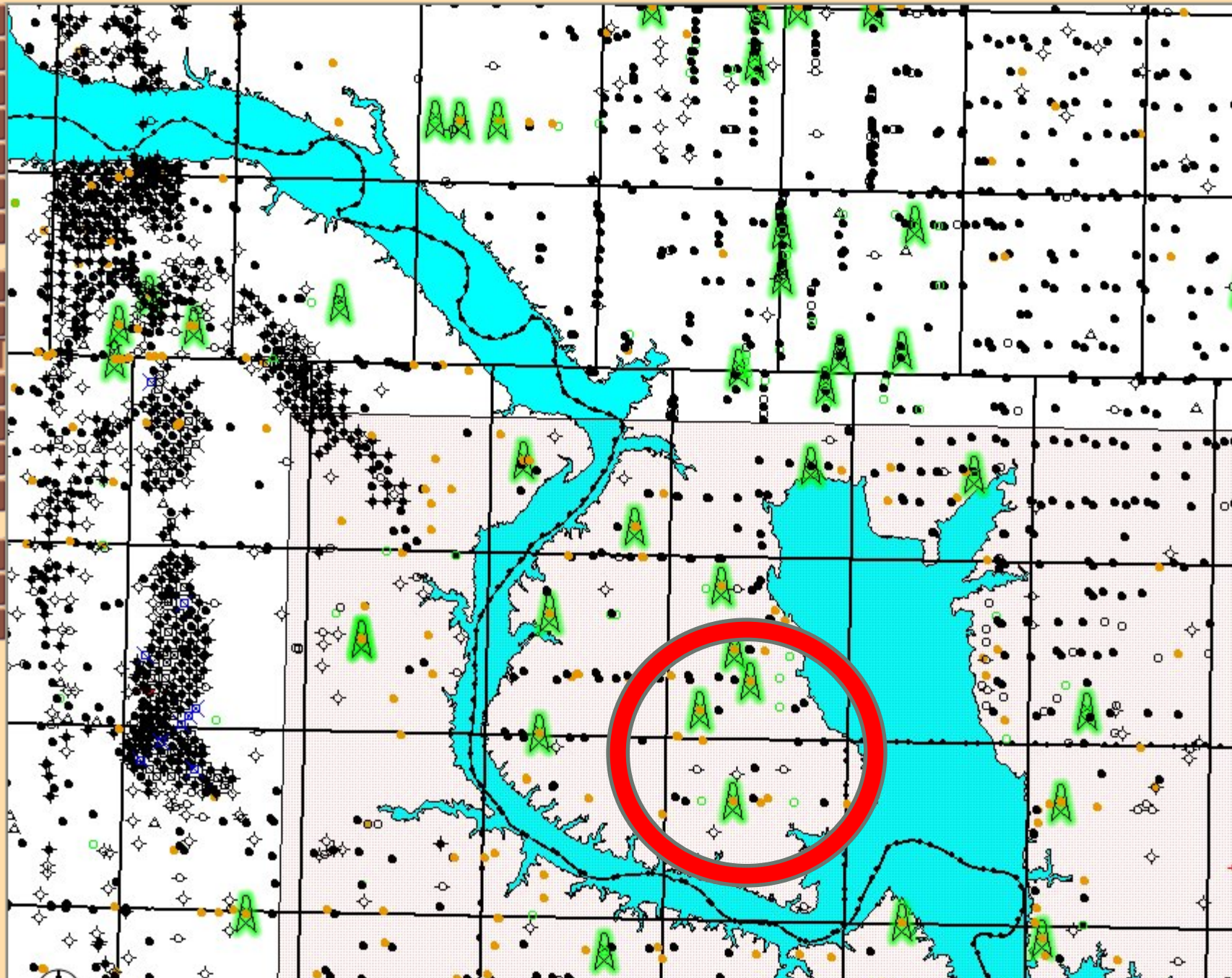

Vern Whitten Photography

https://www.dmr.nd.gov/OaGIMS/viewer.htm

Oil and Gas : ArcIMS Viewer

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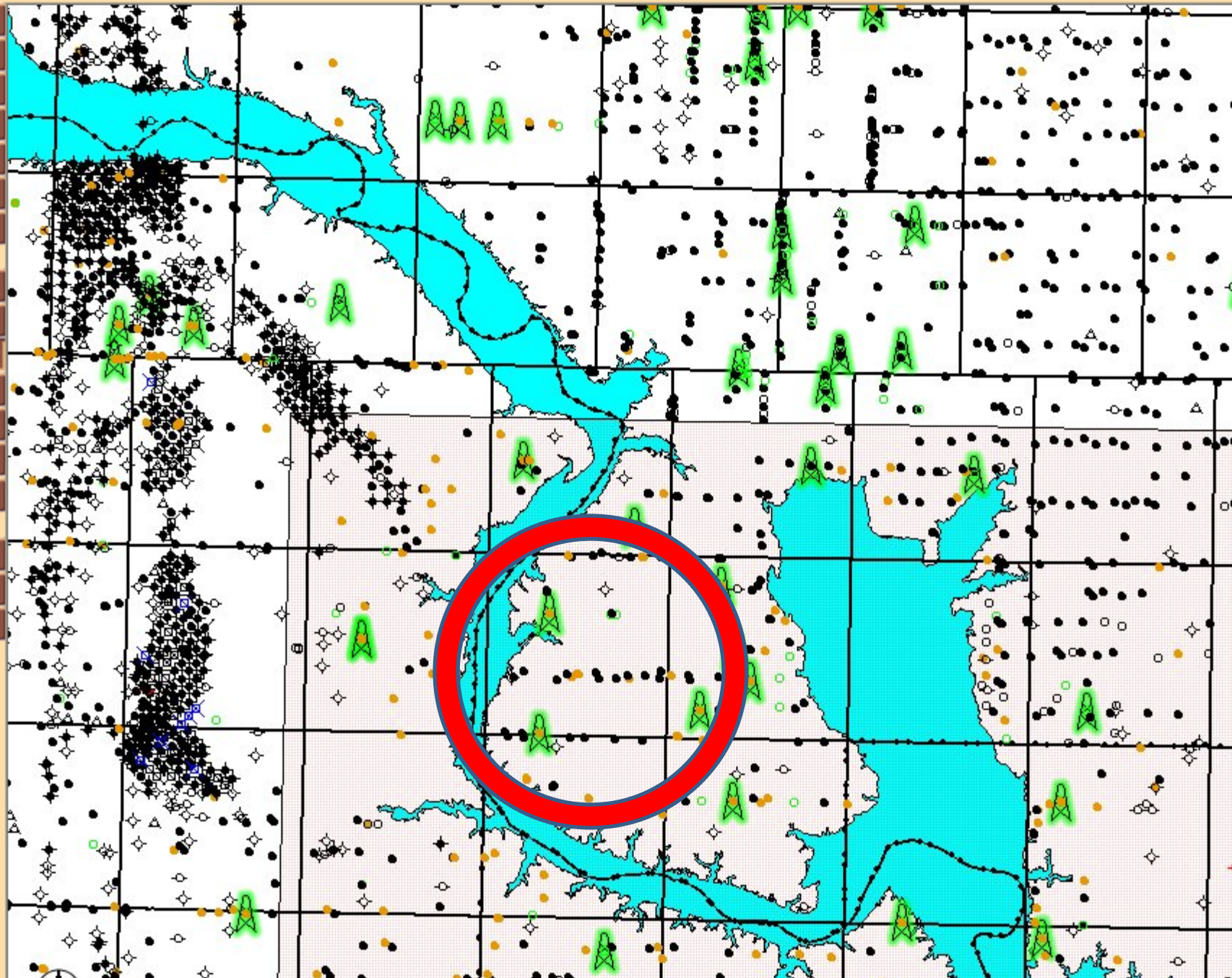
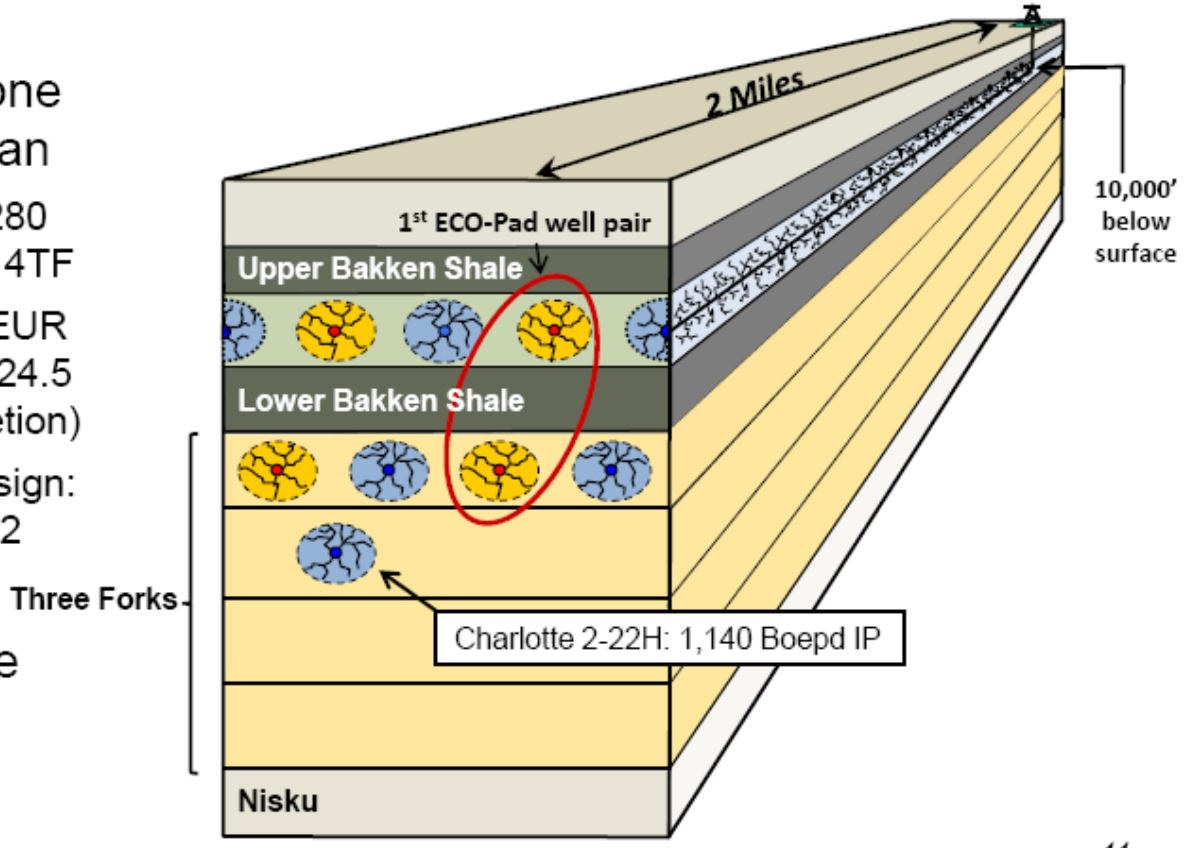



N
Map
Photos
© 2012 Google
Image USDA Farm Service Agency
Google earth
Terms of Use

Bakken Development Plan

- Original dual-zone development plan
  - 8 wells per 1,280 acres – 4 MB, 4TF
  - 603,000 Boe EUR per well (avg. 24.5 stages/completion)
  - ECO-Pad® design: 2 wells south, 2 wells north
- Additional Three Forks potential

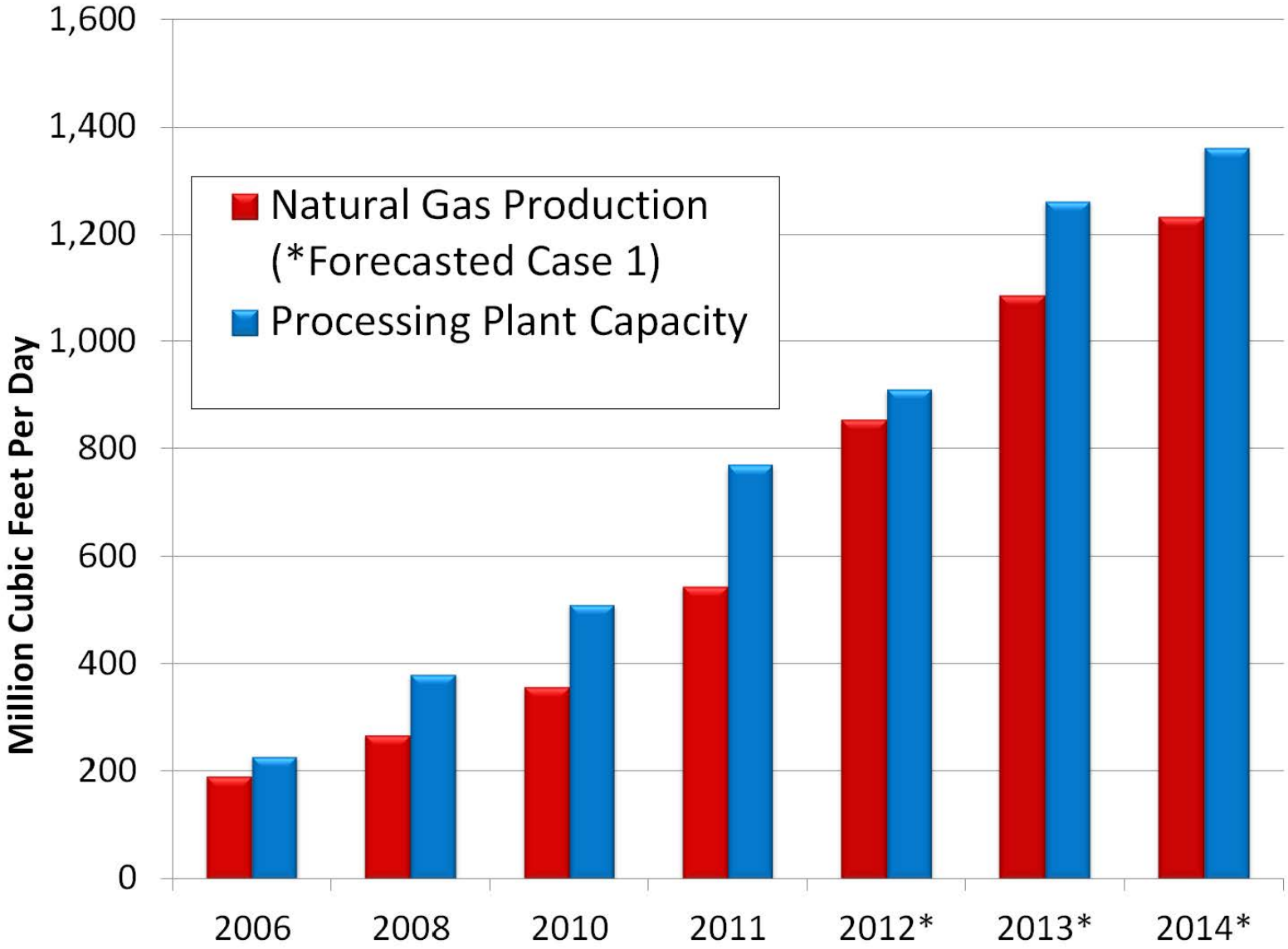


Six Wells on a Single Pad

Vern Whitten Photography

Photo Courtesy: MDU

ND Gas Plant Capacity



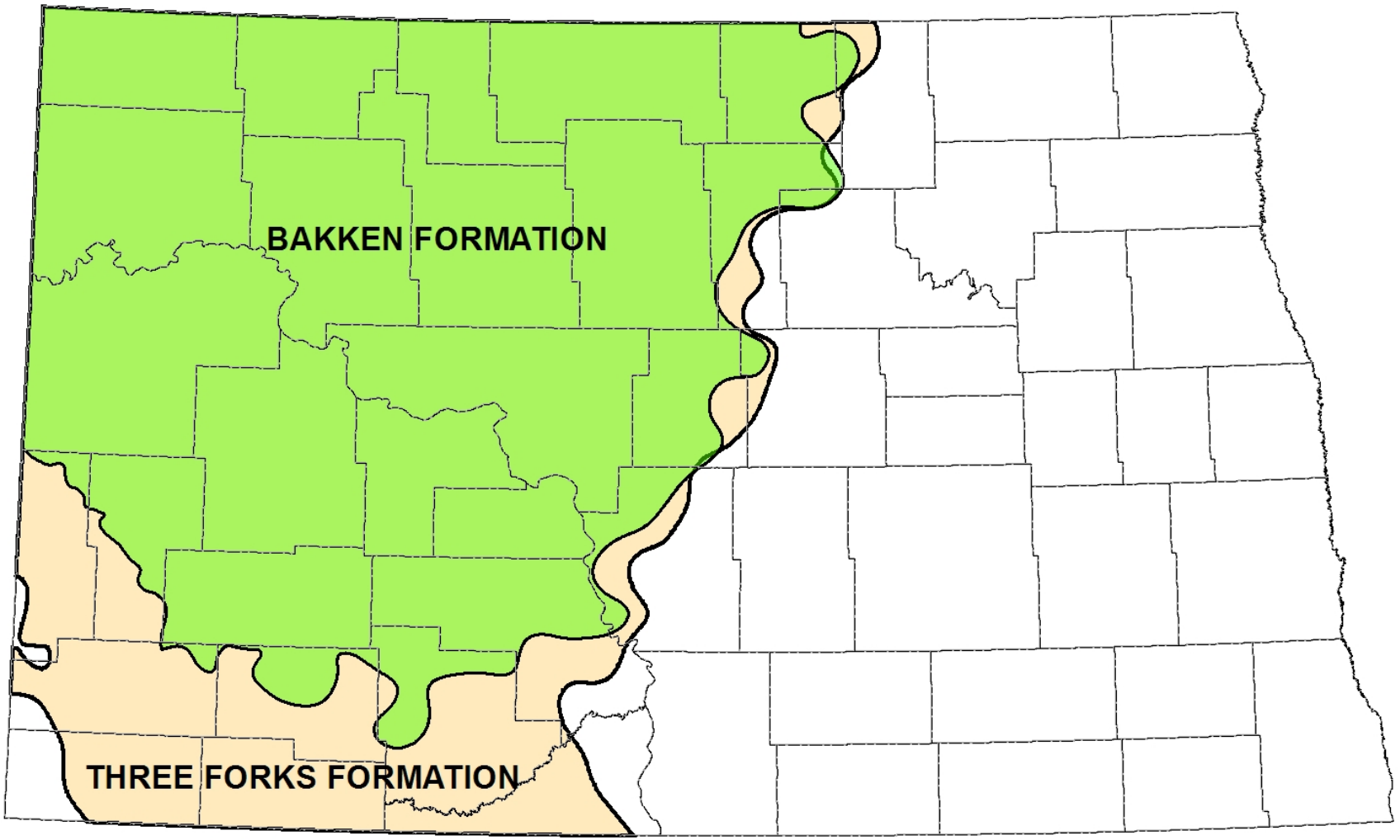
Courtesy: ND Pipeline Authority

BAKKEN BASICS:

HOW DID WE GET HERE?

Resource Plays

- 1) **Large area** of organic-rich source rock.
- 2) **Heat, pressure, and time to mature** source rock.
- 3) **Expulsion** of hydrocarbons from source rocks into adjacent rocks.
- 4) **Trapping** of hydrocarbons in overlying and underlying reservoirs that are porous, but low permeability.
- 5) **Technology to extract** hydrocarbons using natural or artificial fractures to get economic amounts of petroleum production.


BAKKEN FORMATION
THREE FORKS FORMATION

Bakken Formation

Three Forks Formation

upper shale middle member lower shale

Resource Plays

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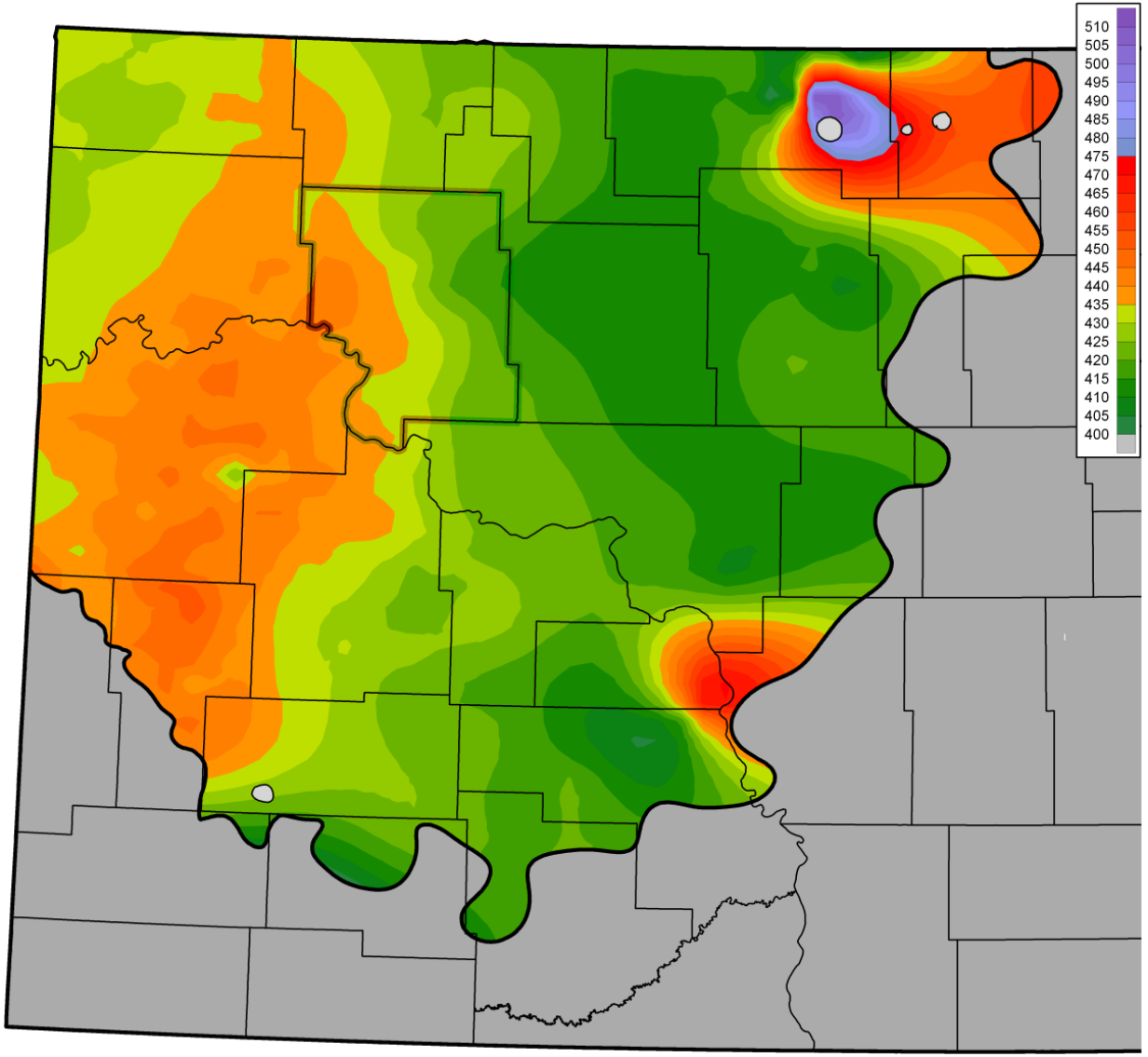
2) Bakken T_{max}: Maturation Index



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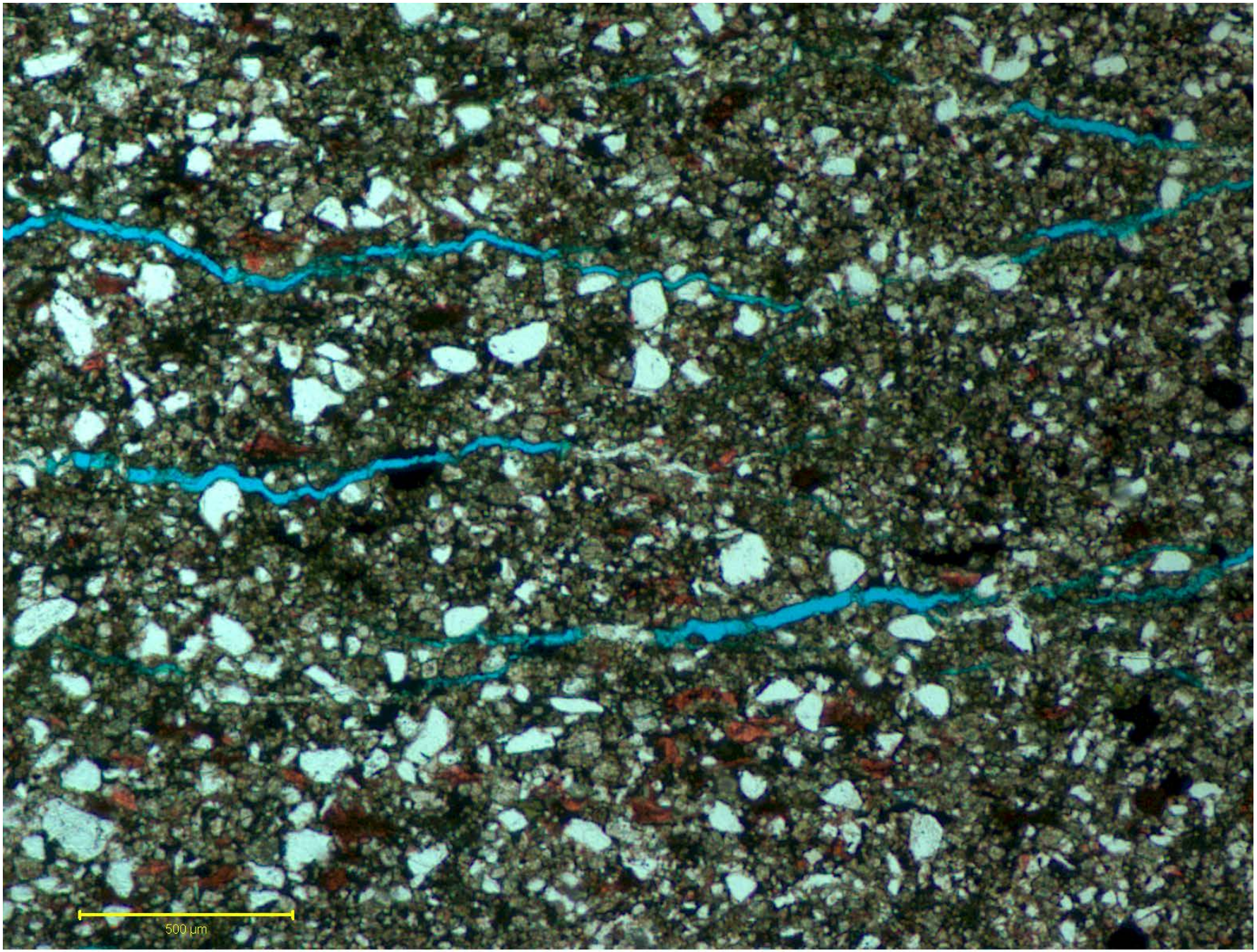
Bakken Formation

Three Forks Formation

upper shale middle member lower shale


500 µm

Resource Plays

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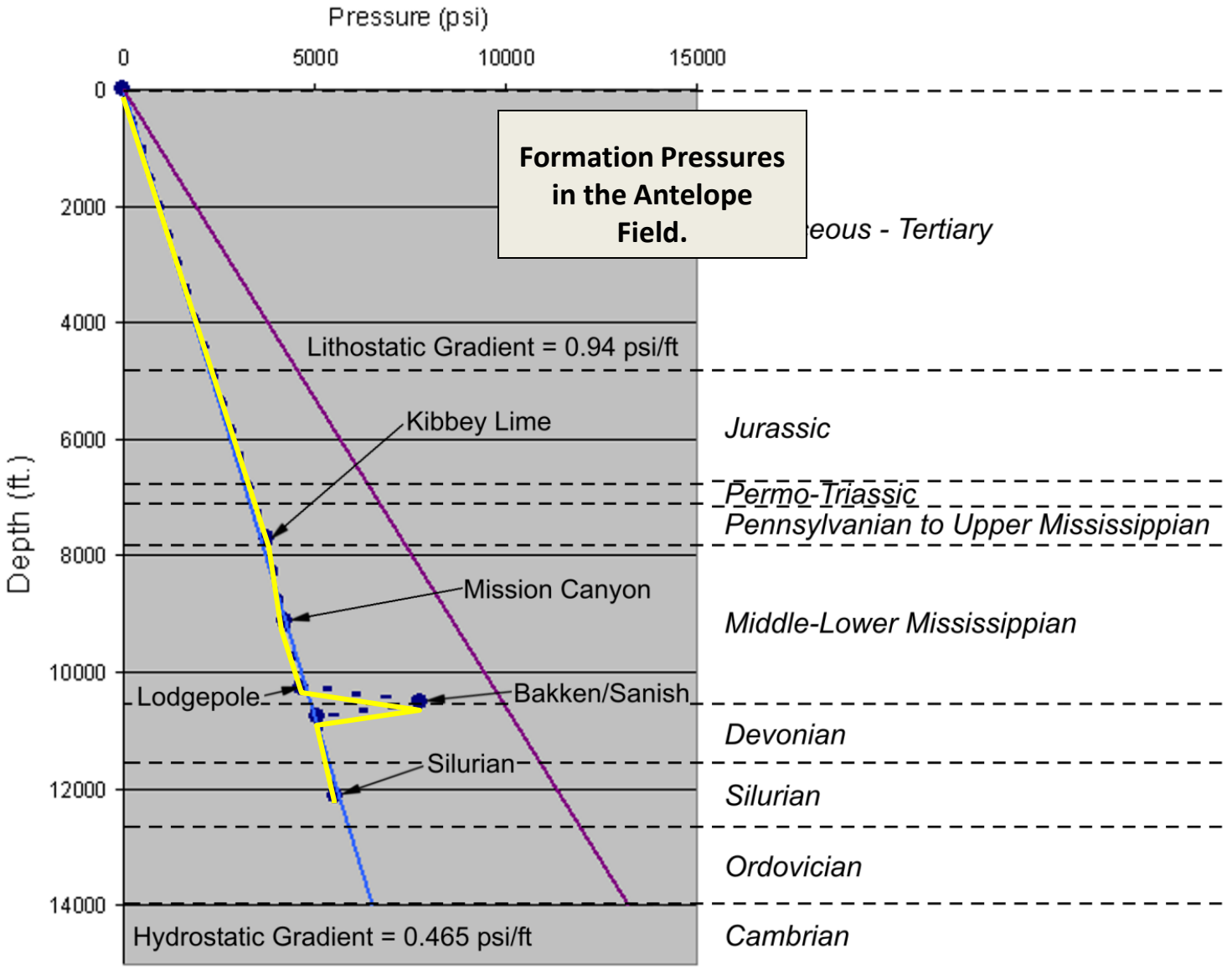
- 5) **Technology to extract** hydrocarbons using natural or artificial fractures to get economic amounts of petroleum production.

4) Trapping → abnormally High Formation Pressure



Modified from Meissner (1978)

Resource Plays

- 1) **Large area** of organic-rich source rock.
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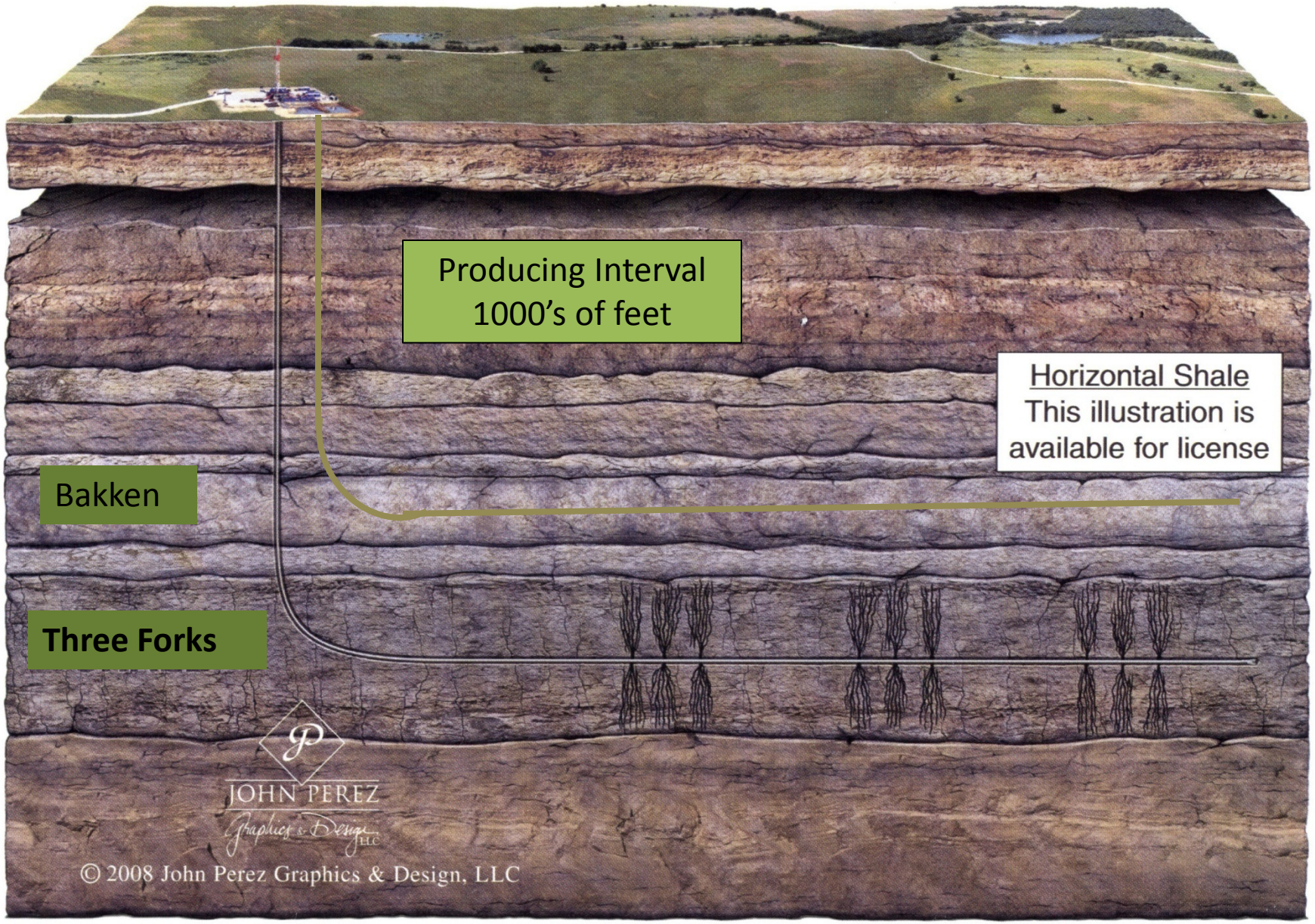
Producing Interval
1000's of feet
Horizontal Shale
This illustration is
available for license
Bakken
Three Forks
JOHN PEREZ
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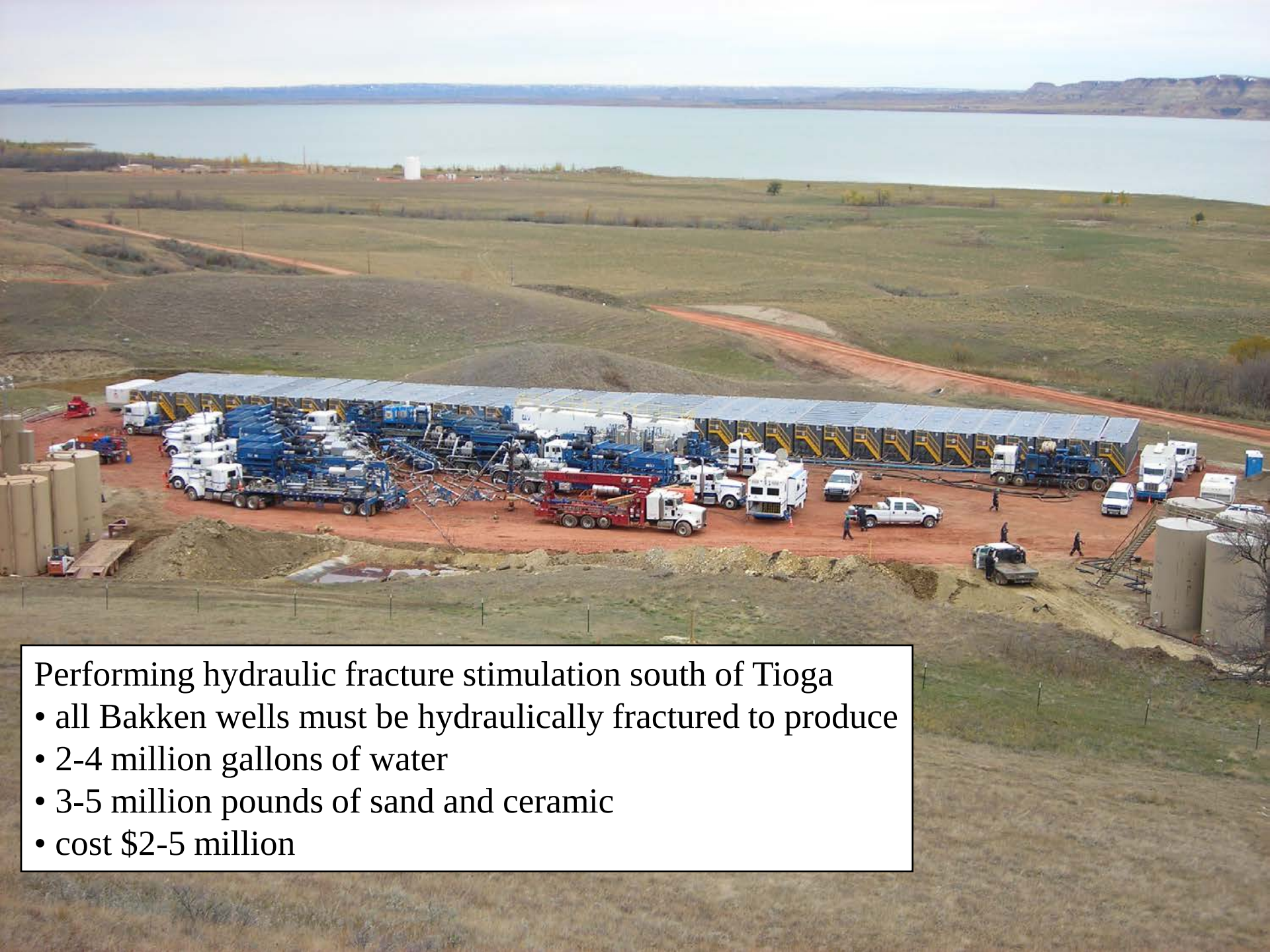
Drilling Voyager Oil Gas.flv



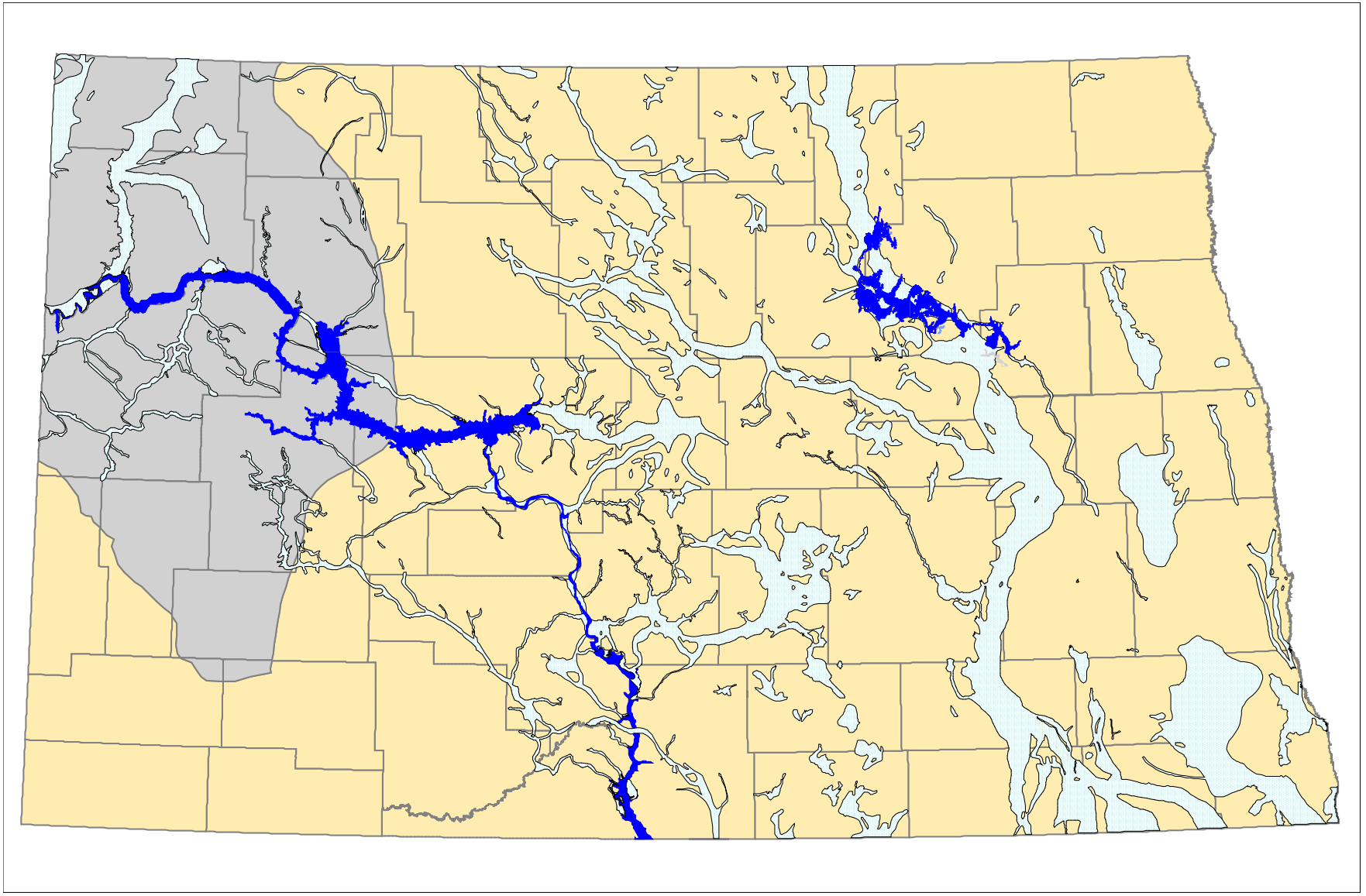
Performing hydraulic fracture stimulation south of Tioga

- all Bakken wells must be hydraulically fractured to produce
- 2-4 million gallons of water
- 3-5 million pounds of sand and ceramic
- cost $2-5 million

Thirsty Horizontal Wells

- 2,000 - 3,000 wells / year
- 15 - 25 years duration
- 20 - 30 million gallons water / day

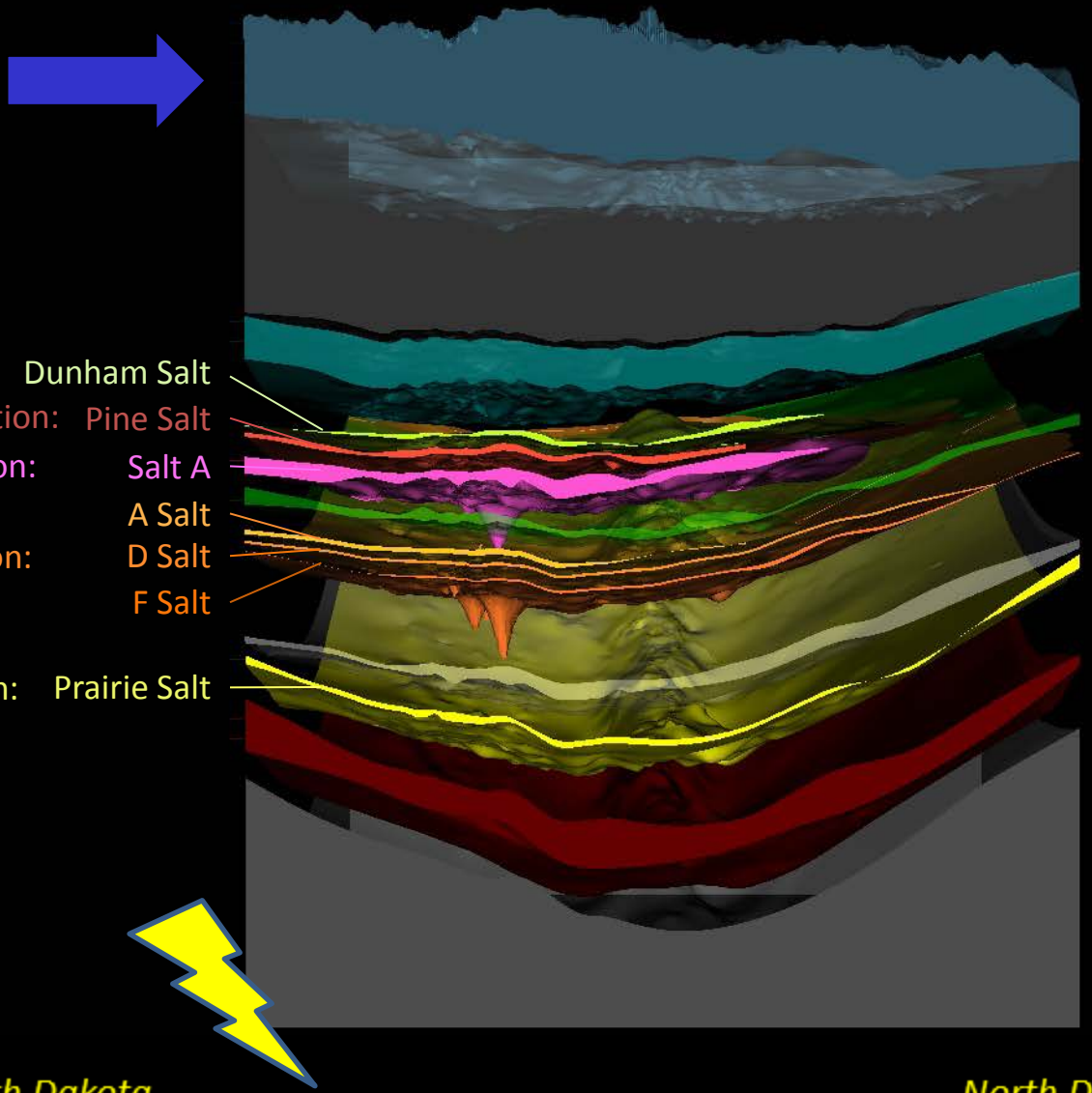
Glacial Drift Aquifers



FRAC WATER NEEDS

- Lake Sakakawea (Missouri River) is the best water resource
  - one inch contains 10 billion gal water
    - 30 million gallons per day for 1 year

Significant Salt Intervals of Northwestern North Dakota



Piper Formation: Dunham Salt
Spearfish Formation: Pine Salt
Opeche Formation: Salt A
A Salt
Charles Formation: D Salt
F Salt
Prairie Formation: Prairie Salt

Fresh Water Zone
Shallow Gas Zone
Dakota Group
Spearfish Formation
Tyler Formation
Madison Group
Bakken-Three Forks
Prairie Formation
Red River Formation
Precambrian Basement

North Dakota Geological Survey

North Dakota Depart. of Mineral Resources

Hydraulic Fracturing Stimulation is Safe

- IOGCC survey—no contamination
- EPA survey – no contamination
- GWPC study verifies State's regs
- GWPC - IOGCC FracFocus Chemical Registry

- **Compound**
  - **Purpose**
    - **Common application**

- Fresh **Water** – 80.5%
- Proppant – 19.0%
  - Allows the fractures to remain open so the oil and gas can escape
    - Drinking water filtration, **play ground sand**
- Acids - 0.12%
  - Help dissolve minerals and initiate fractures in rock (pre-fracture)
    - **Swimming pool cleaner**
- Petroleum distillates – 0.088%
  - Dissolve polymers and minimize friction
    - **Make-up remover**, laxatives, and candy
- Isopropanol – 0.081%
  - Increases the viscosity of the fracture fluid
    - **Glass cleaner**, antiperspirant, and hair color
- Potassium chloride – 0.06%
  - Creates a brine carrier fluid
    - Low-sodium **table salt substitute**
- Guar gum – 0.056%
  - Thickens the water to suspend the sand
    - **Thickener used in cosmetics**, baked goods, ice cream, toothpaste, sauces, and salad dressing
- Ethylene glycol – 0.043%
  - Prevents scale deposits in the pipe
    - Automotive **antifreeze**, household cleansers, deicing, and caulk

- Sodium or potassium carbonate – 0.011%
  - Improves the effectiveness of other components, such as cross-linkers
    - Washing soda, detergents, **soap**, water softeners, glass and ceramics
- Sodium Chloride – 0.01%
  - Delays break down of the gel polymer chains
    - **Table Salt**
- Polyacrylamide – 0.009%
  - Minimizes friction between fluid and pipe
    - **Water treatment**, soil conditioner
- Ammonium bisulfite – 0.008%
  - Removes oxygen from the water to protect the pipe from corrosion
    - Cosmetics, **food and beverage processing**, water treatment
- Borate salts – 0.007%
  - Maintain fluid viscosity as temperature increases
    - Used in laundry **detergents**, hand soaps and cosmetics
- Citric Acid – 0.004%
  - Prevents precipitation of metal oxides
    - **Food additive**; food and beverages; lemon juice
- N, n-Dimethyl formamide – 0.002%
  - Prevents the corrosion of the pipe
    - Used in **pharmaceuticals**, acrylic fibers and plastics
- Glutaraldehyde – 0.001%
  - Eliminates bacteria in the water
    - **Disinfectant**; Sterilizer for medical and dental equipment

Find a Well

Back To Search

Next Page

Page 1 of 5 Go

	API No.	Job Date	State	County	Operator	WellName	Well Type	Latitude	Longitude	Datum
	33-025-01132	4/13/2011	North Dakota	Dunn	XTO Energy/ExxonMobil	Alwin Federal 12X-19	Oil	47.627564	-102.967017	NAD83
	33-105-01913	4/18/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Lonnie 31X-3	Oil	48.196639	-102.880264	NAD83
	33-105-01824	5/14/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Allen 21X-17	Oil	48.254792	-103.058819	NAD83
	33-105-01825	4/28/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Woodrow 34X-32	Oil	48.198603	-103.053617	NAD83
	33-053-03113	3/22/2011	North Dakota	Mc Kenzie	XTO Energy/ExxonMobil	101 Federal 21X-24	Oil	47.546178	-104.000694	NAD83
	33-105-01948	2/26/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Normark 24X-31	Oil	48.460233	-103.008811	NAD83
	33-105-01899	2/17/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Michael State 31X-16	Oil	48.167464	-103.031950	NAD83
	33-025-01165	5/9/2011	North Dakota	Dunn	Marathon Oil	Lucky Fleckenstien #34-20H	Oil	47.264306	-102.330608	NAD83
	33-025-01173	5/3/2011	North Dakota	Dunn	Marathon Oil	Wardner #24-35H	Oil	47.245872	-102.445641	NAD83

Find a Well

Map Search | Standard Search

STATE: North Dakota

COUNTY: Williams

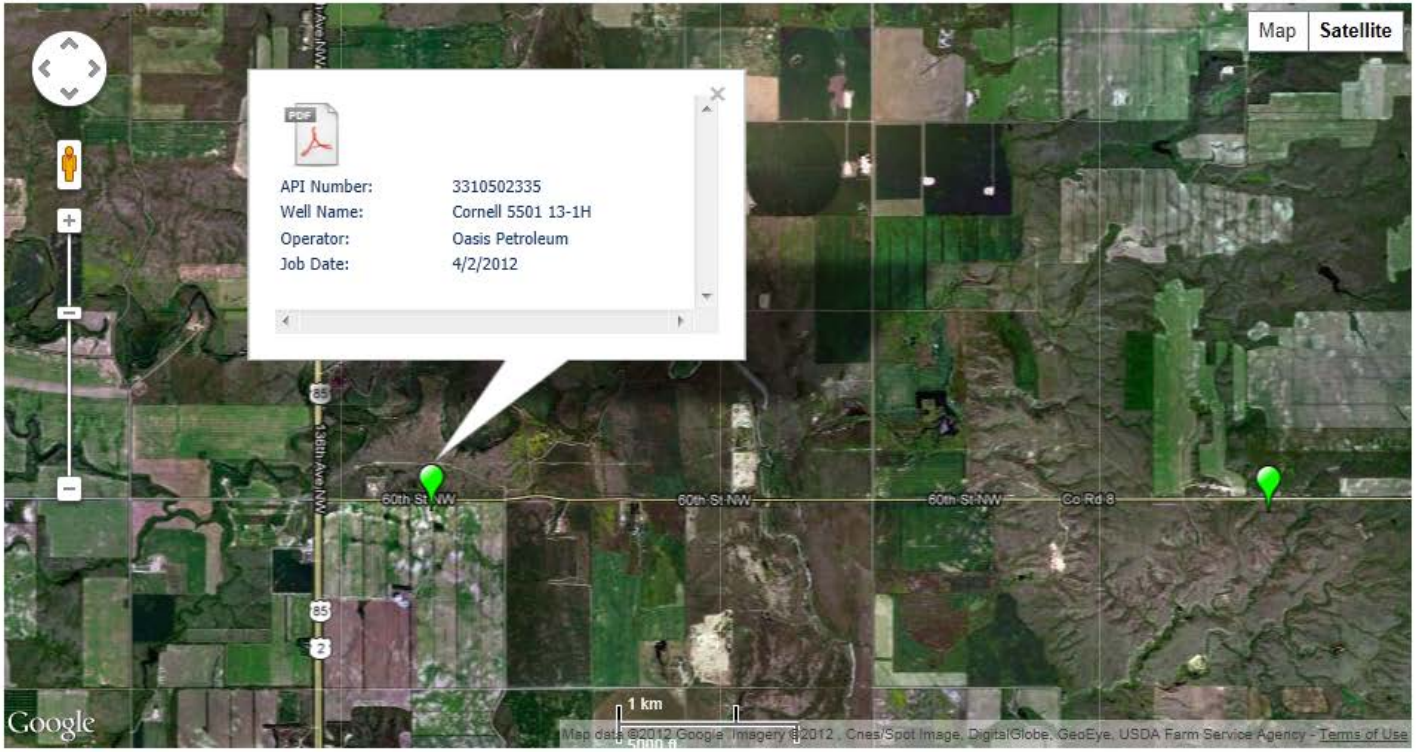
WELLS IN COUNTY: Choose a Well Name

OPERATOR: Choose One

API WELL NUMBER: __-___-_____

WELL NAME:

Search Reset Not Seeing Map Markers? Please Click The "Reset" Button (left).



All FracFocus well site information is voluntarily provided by participating oil and natural gas operators. Wells hydraulically fractured after January 1, 2011 will be added to the database over time.

See the full list of participating production companies.

BAKKEN BASICS:
WHAT COULD CHANGE?

Draft EPA guidance on diesel fuel in hydraulic fracturing could triple drilling permit approval time or worse. Comments due 7/9/12

Draft BLM Hydraulic Fracturing rule could double federal drilling permit approval time or worse. Comments due in September

The future looks promising for sustained Bakken/Three Forks development

World and U.S. economies continue to struggle. If China joins the downward spiral oil price could fall enough to make some areas uneconomic

QUESTIONS?

- **Alison Ritter**
- **Department of Mineral Resources**
- **Public Information Officer**
- **amritter@nd.gov**
- **701-328-8036**