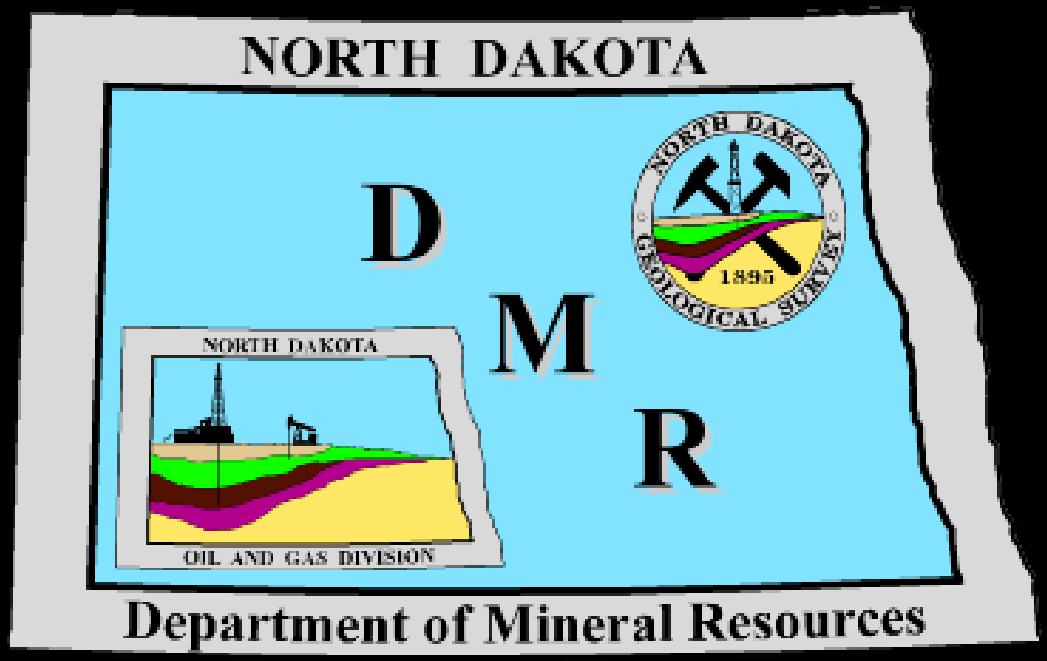
North Dakota Department of Mineral Resources



http://www.oilgas.nd.gov

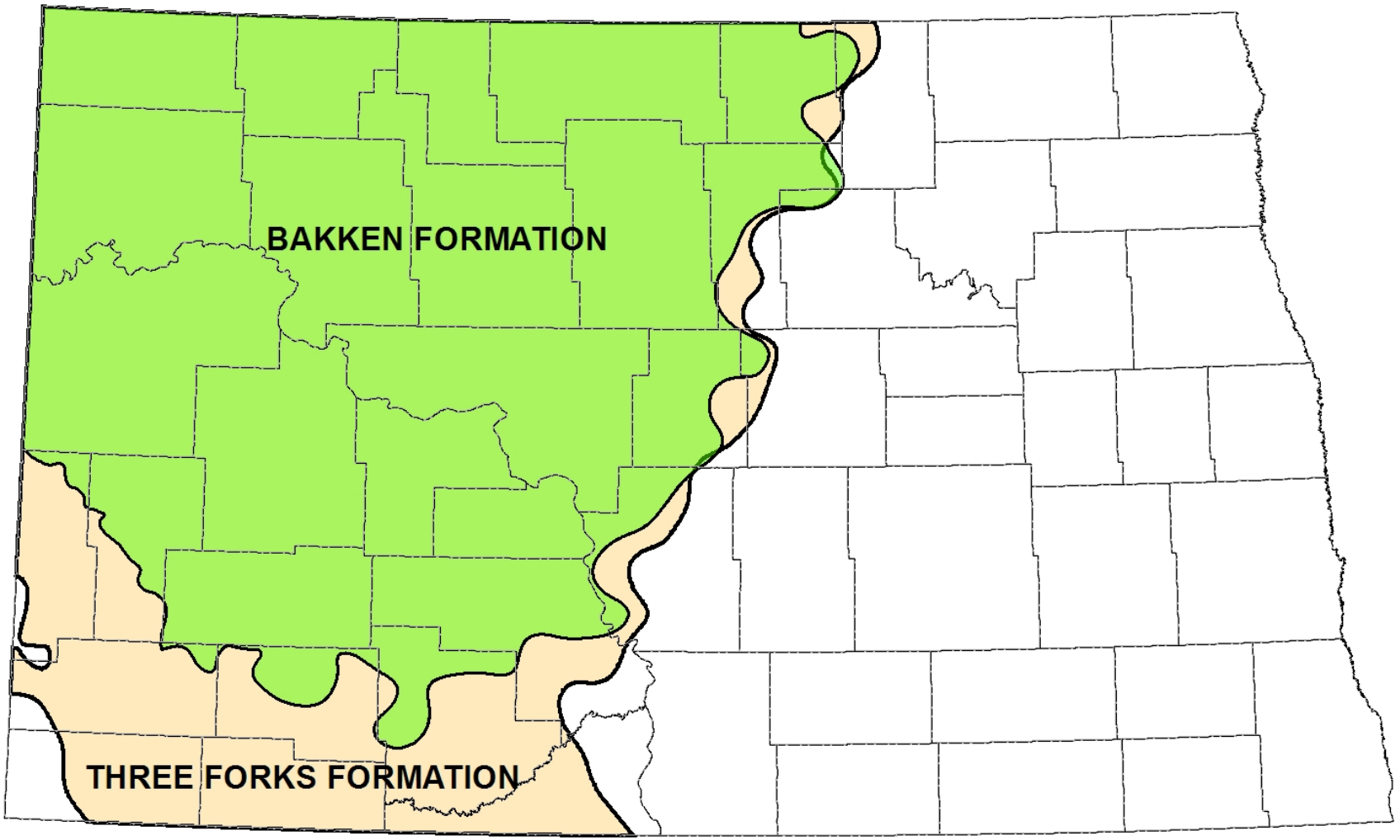
http://www.state.nd.us/ndgs

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

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

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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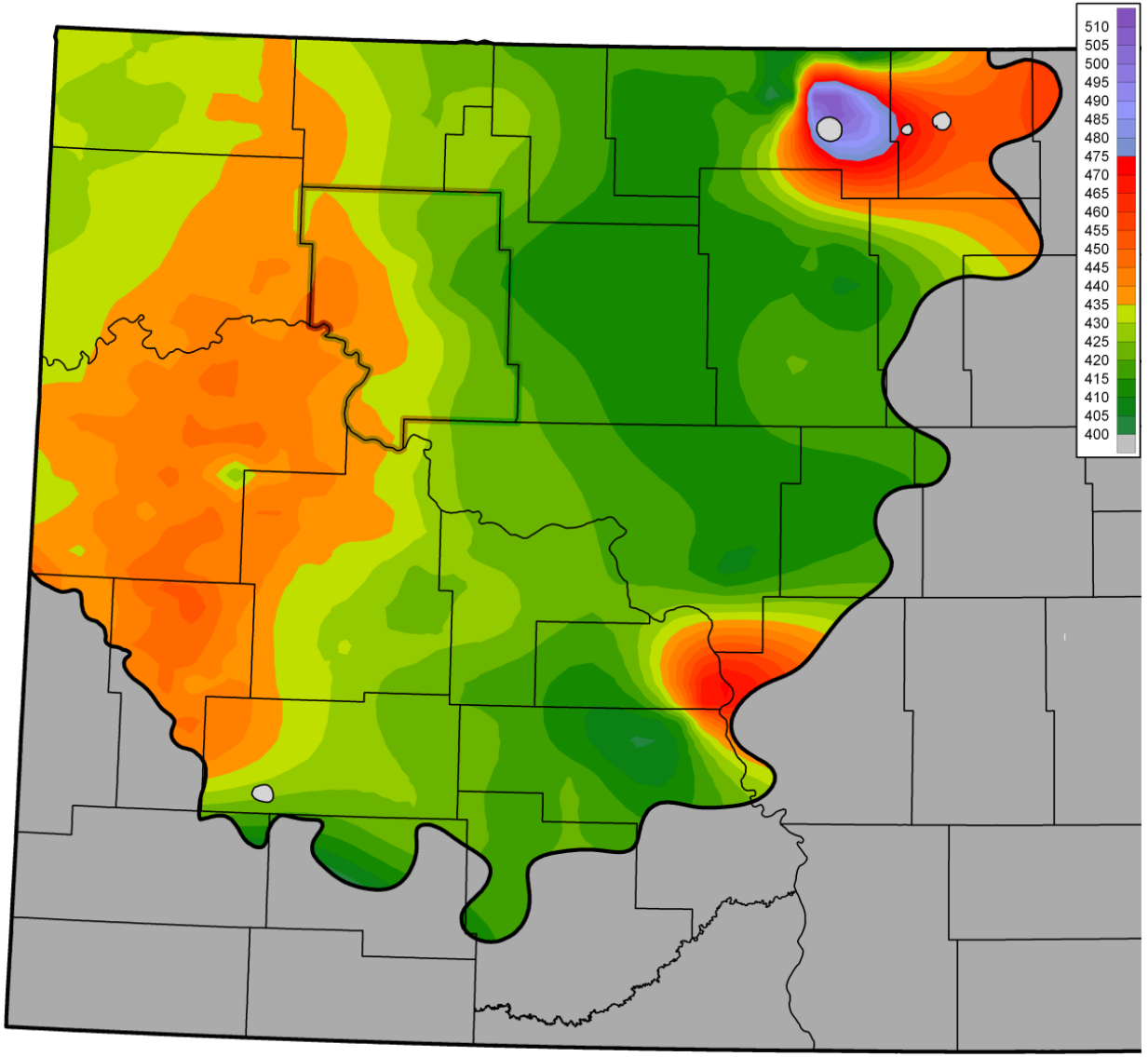
2) Bakken T_{max}: Maturation Index



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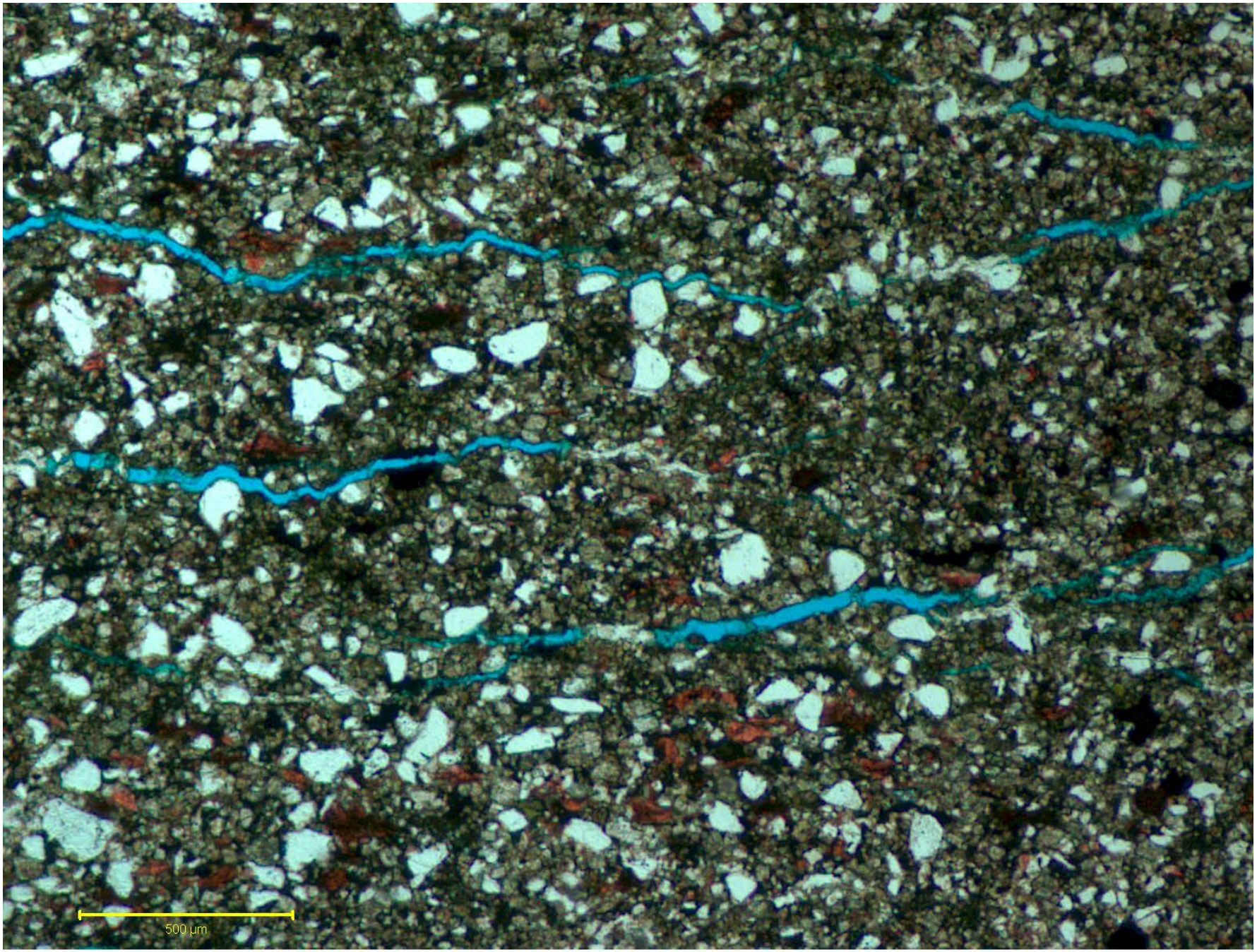
500 µm

Resource Plays

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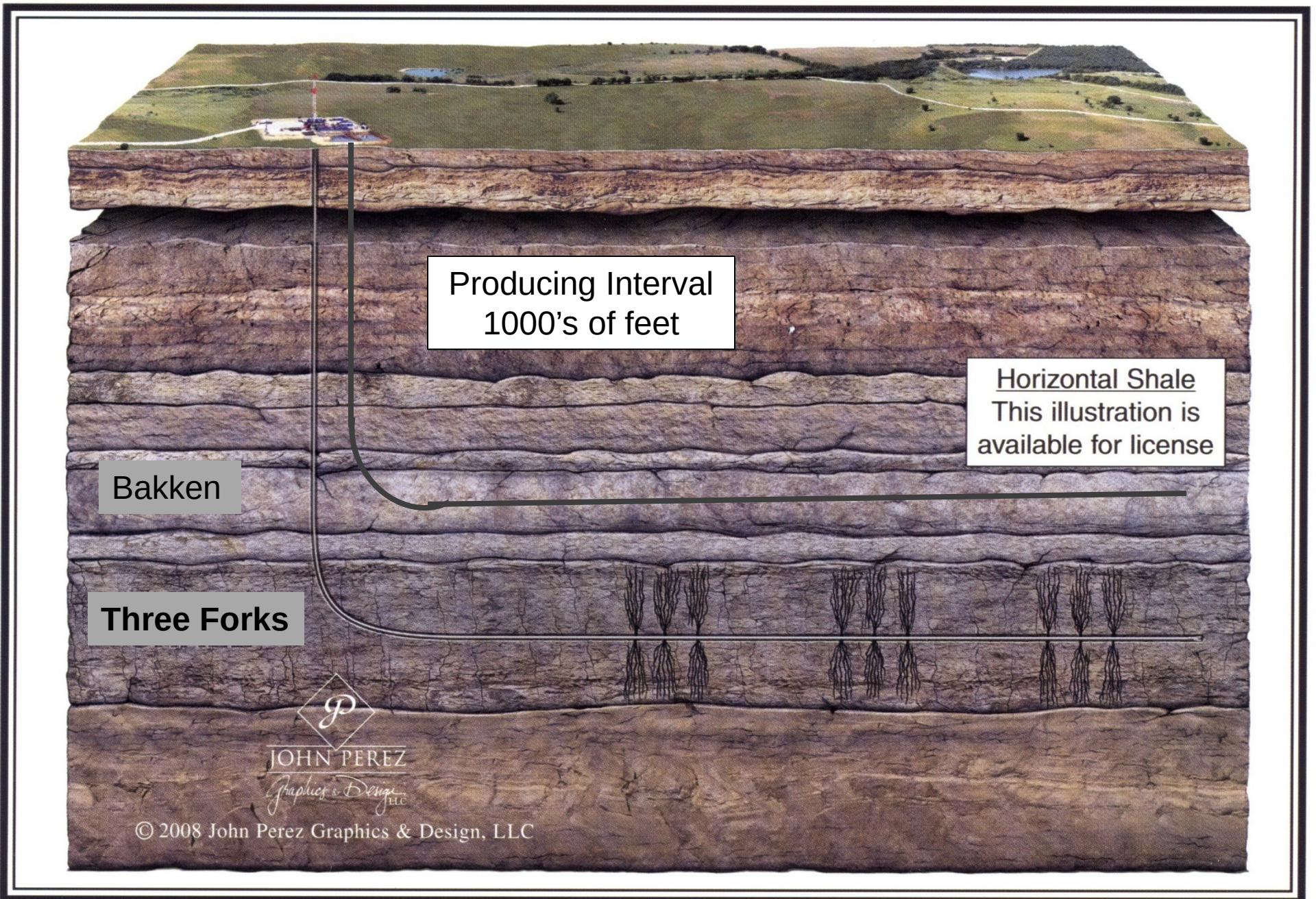
- 4) **Trapping** of hydrocarbons in overlying and underlying reservoirs that are porous, but low permeability.
- 5) **Technology to extract** hydrocarbons using natural or artificial fractures to get economic amounts of petroleum production.

5) Technology = horizontal well / multi stage hydraulic fractured



Drilling Voyager Oil Gas.flv

North Dakota Challenges

Housing and Infrastructure

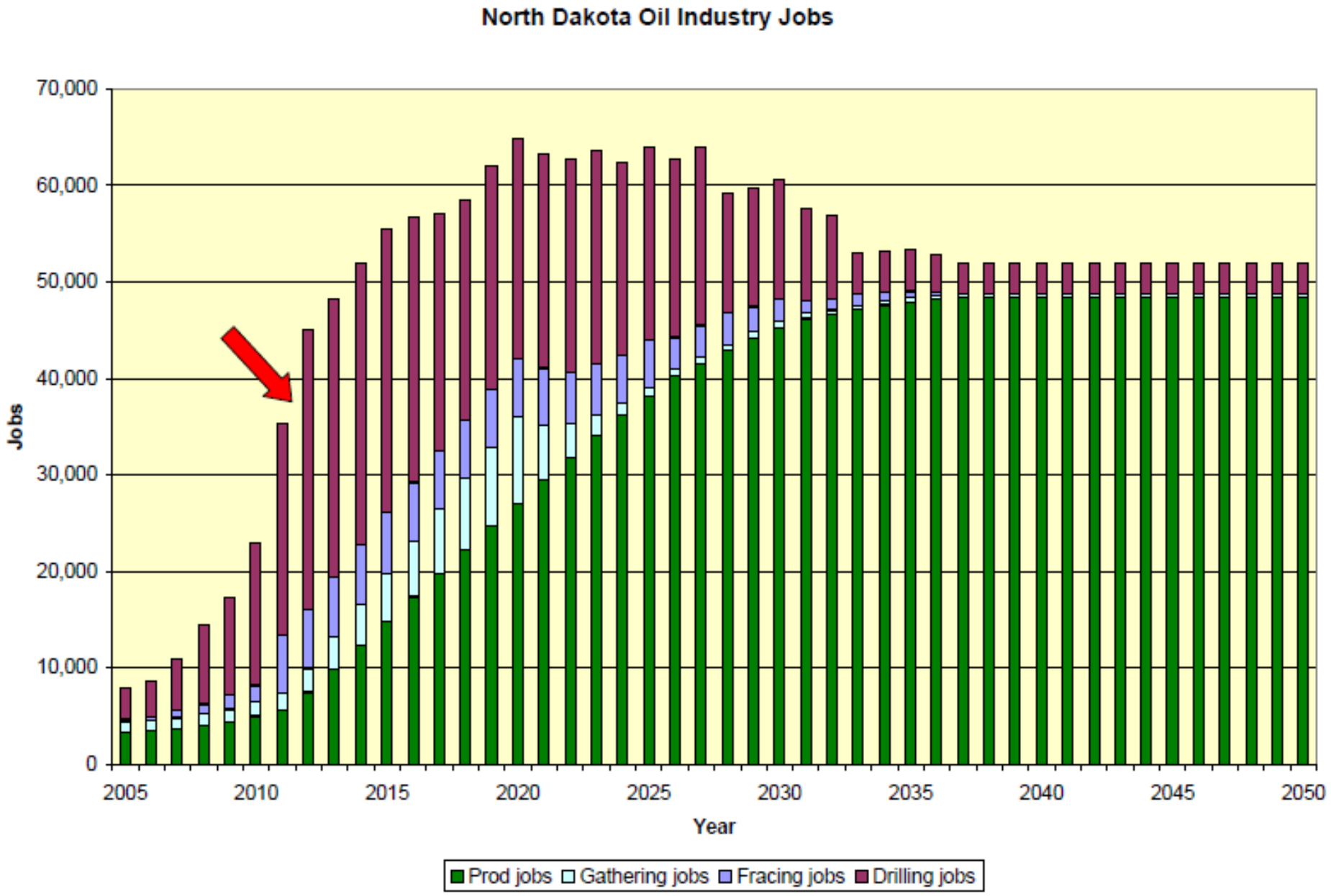
Resource protection

- Ground water
- Surface water

Resource conservation

- Land and wildlife

Expected Case



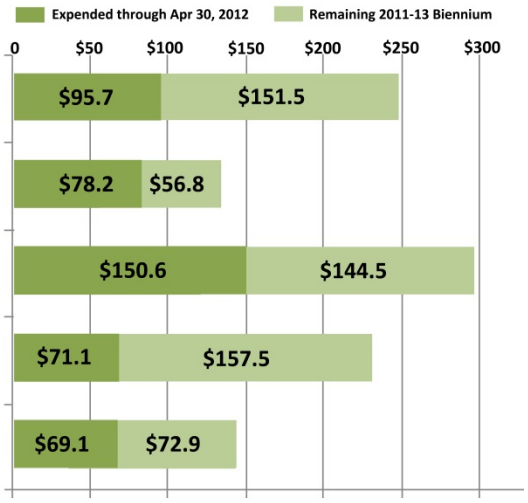
WESTERN NORTH DAKOTA ROADS, WATER, & HOUSING

Status of 2011-13 Biennium Expenditures and Allocations

as of April 30, 2012

(in millions)

INFRASTRUCTURE



Oil & Gas Tax Distributions to Cities & Counties
$95.7 mm distributed out of $247.2 mm total

Energy Impact Grant Expenditures
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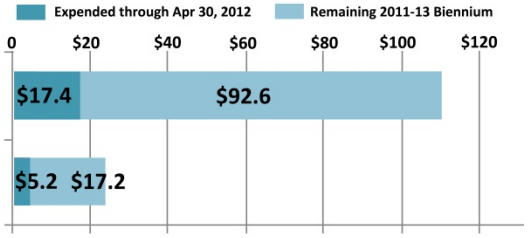
$150.6 mm expended out of $295.1 mm total

Special State Highway Maintenance Program
$71.1 mm expended out of $228.6 mm total

County & Township Road Reconstruction Program
$69.1 mm expended out of $142.0 mm total

WATER



Western Area Water Supply Program
$17.4 mm expended out of $110 mm total

Southwest Water Pipeline Project
$5.2 mm expended out of $22.4 mm total

$132.4mm

HOUSING

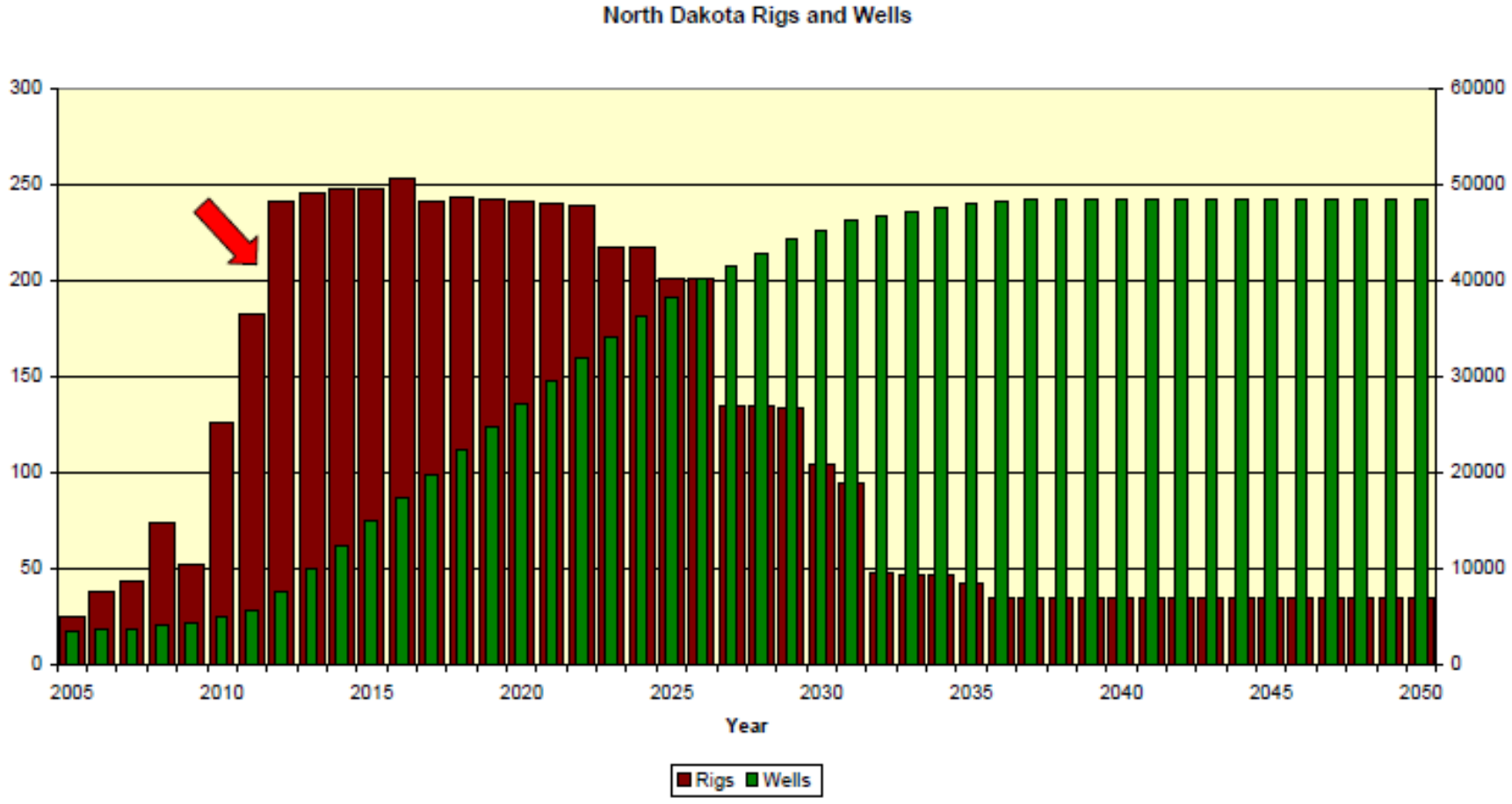
Housing Incentive Fund
$3.9 mm allocated out of $13.5 mm total

Federal Low-Income Housing Tax Credits
$3.9 mm allocated out of $3.9mm total

$17.4mm

TOTAL

Total 2011-13 Biennium Expenditures & Allocations
$495.1 mm expended out of $1,197.7mm total


North Dakota Rigs and Wells
300
250
200
150
100
50
0
60000
50000
40000
30000
20000
10000
0
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Year
Rigs
Wells

WESTERN NORTH DAKOTA ROADS, WATER, & HOUSING

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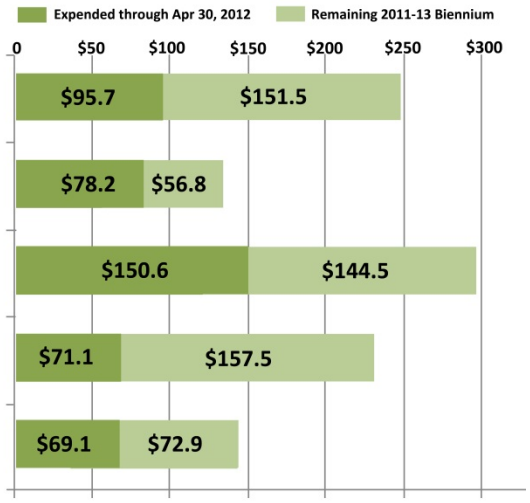

$1.048b

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Southwest Water Pipeline Project
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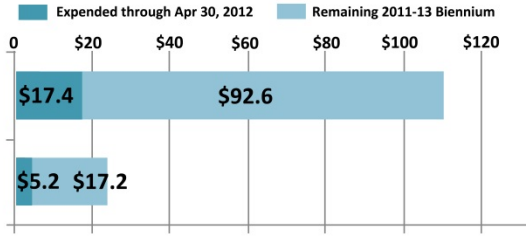

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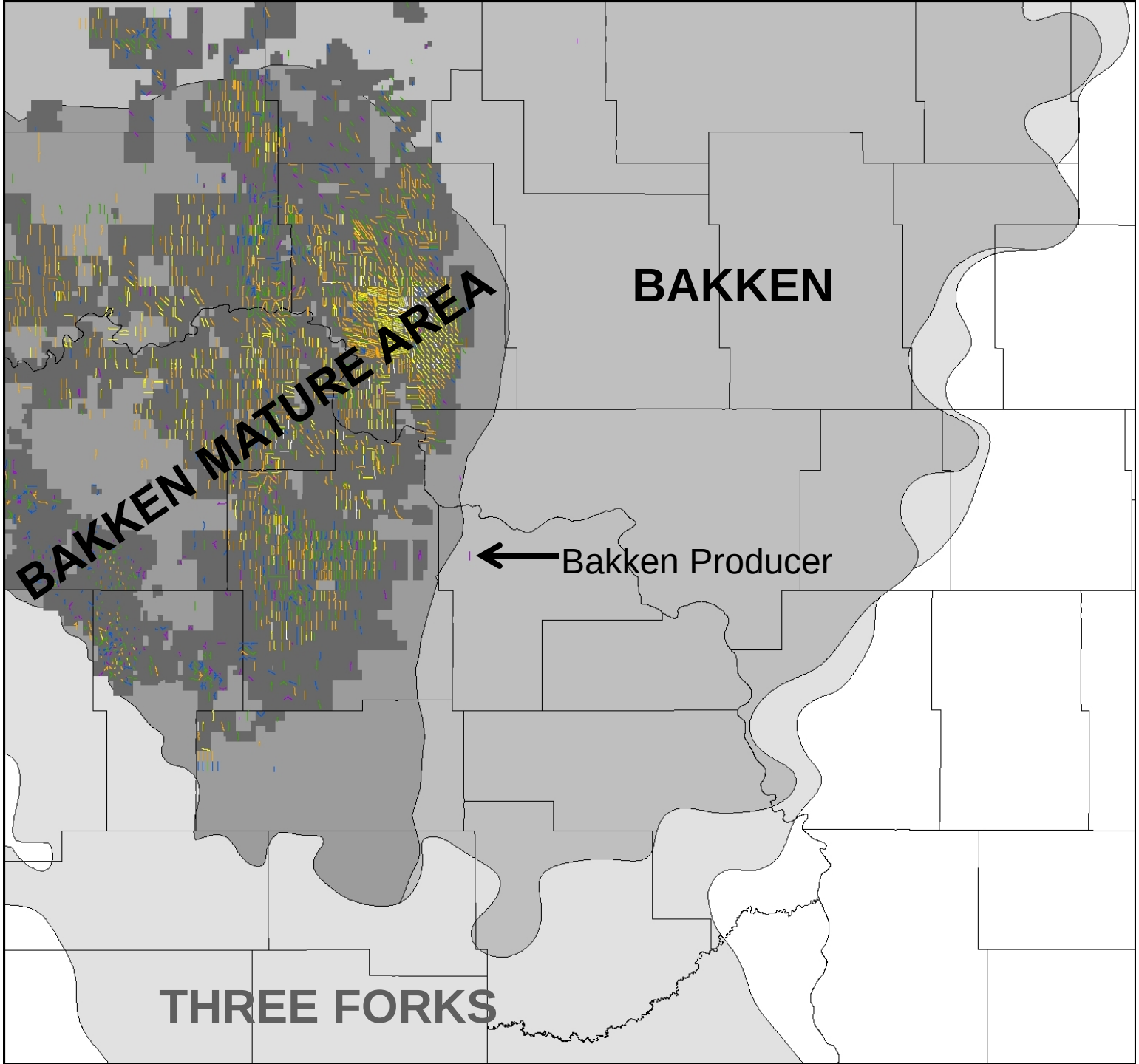
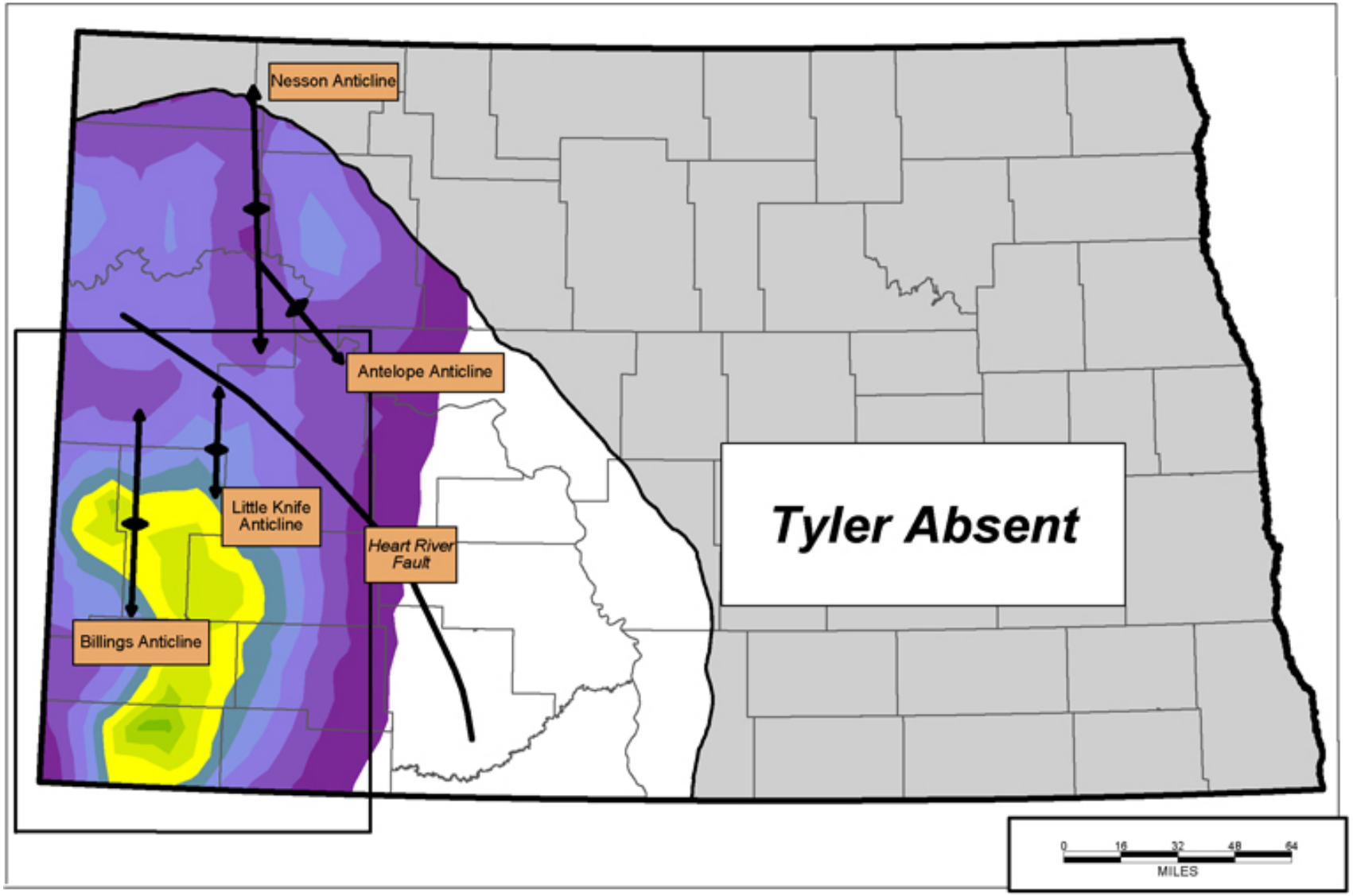
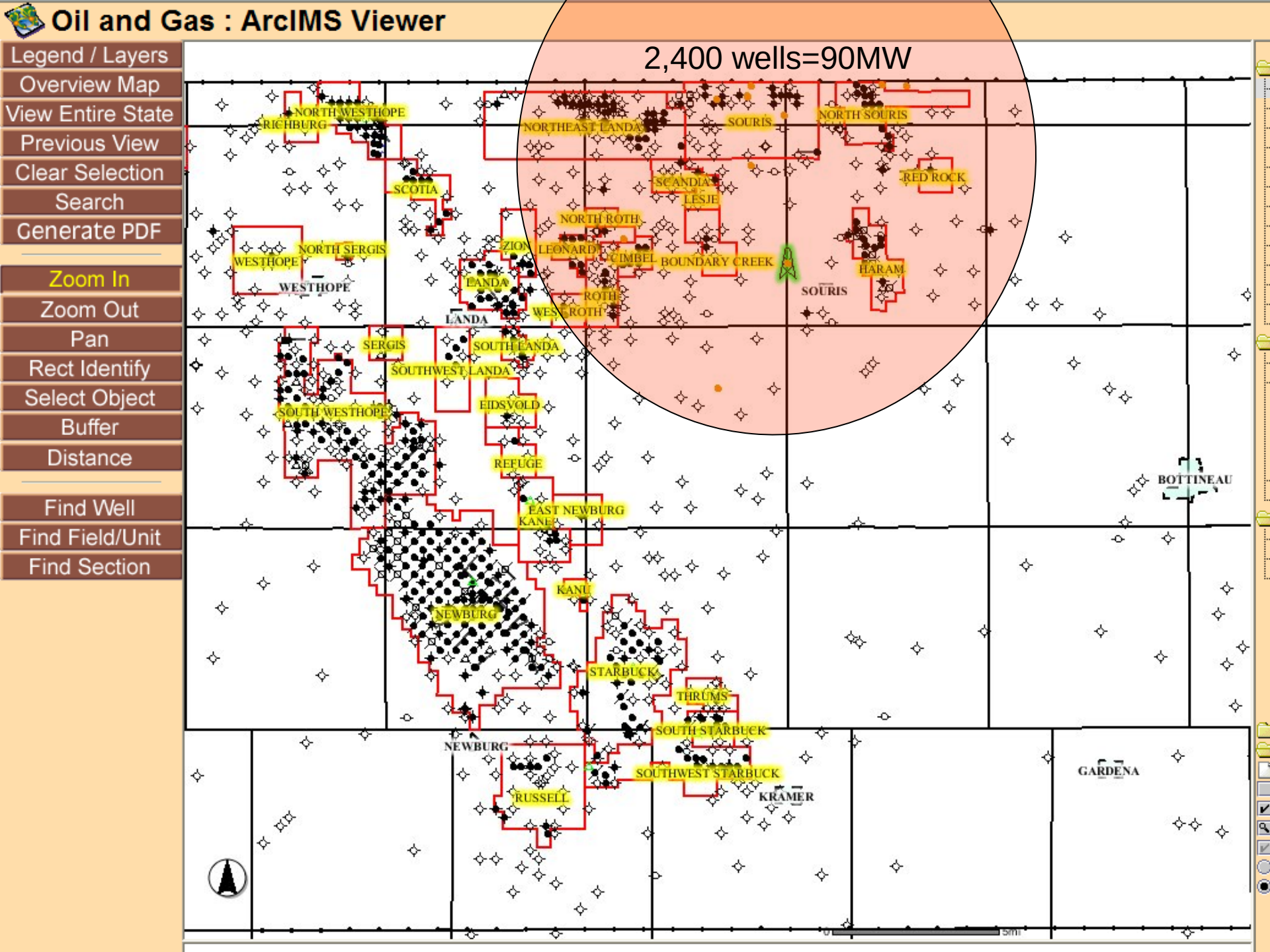

BAKKEN
BAKKEN MATURE AREA
Bakken Producer
THREE FORKS


Nesson Anticline
Antelope Anticline
Little Knife Anticline
Heart River Fault
Billings Anticline
Tyler Absent
0
16
32
48
64
MILES


Oil and Gas : ArcIMS Viewer
Legend / Layers
Overview Map
View Entire State
Previous View
Clear Selection
Search
Generate PDF
Zoom In
Zoom Out
Pan
Rect Identify
Select Object
Buffer
Distance
Find Well
Find Field/Unit
Find Section
2,400 wells=90MW
NORTH WESTHOPE
RICHBURG
SCOTIA
NORTH SERGIS
WESTHOPE
WESTHOPE
LANDA
SERGIS
SOUTH LANDA
SOUTHWEST LANDA
SOUTH WESTHOPE
EIDSVOLD
REFUGE
EAST NEWBURG
KANE
KANU
NEWBURG
NEWBURG
STARBUCK
THRUMS
SOUTH STARBUCK
SOUTHWEST STARBUCK
KRAMER
RUSSELL
GARDENA
BOTTINEAU
NORTHEAST LANDA
SOURIS
NORTH SOURIS
RED ROCK
SCANDIA
LESJE
NORTH ROTH
ZION
LEONARD
CIMBEL
BOUNDARY CREEK
HARAM
SOURIS
ROTH
WEST ROTH
LANDA

North Dakota Challenges

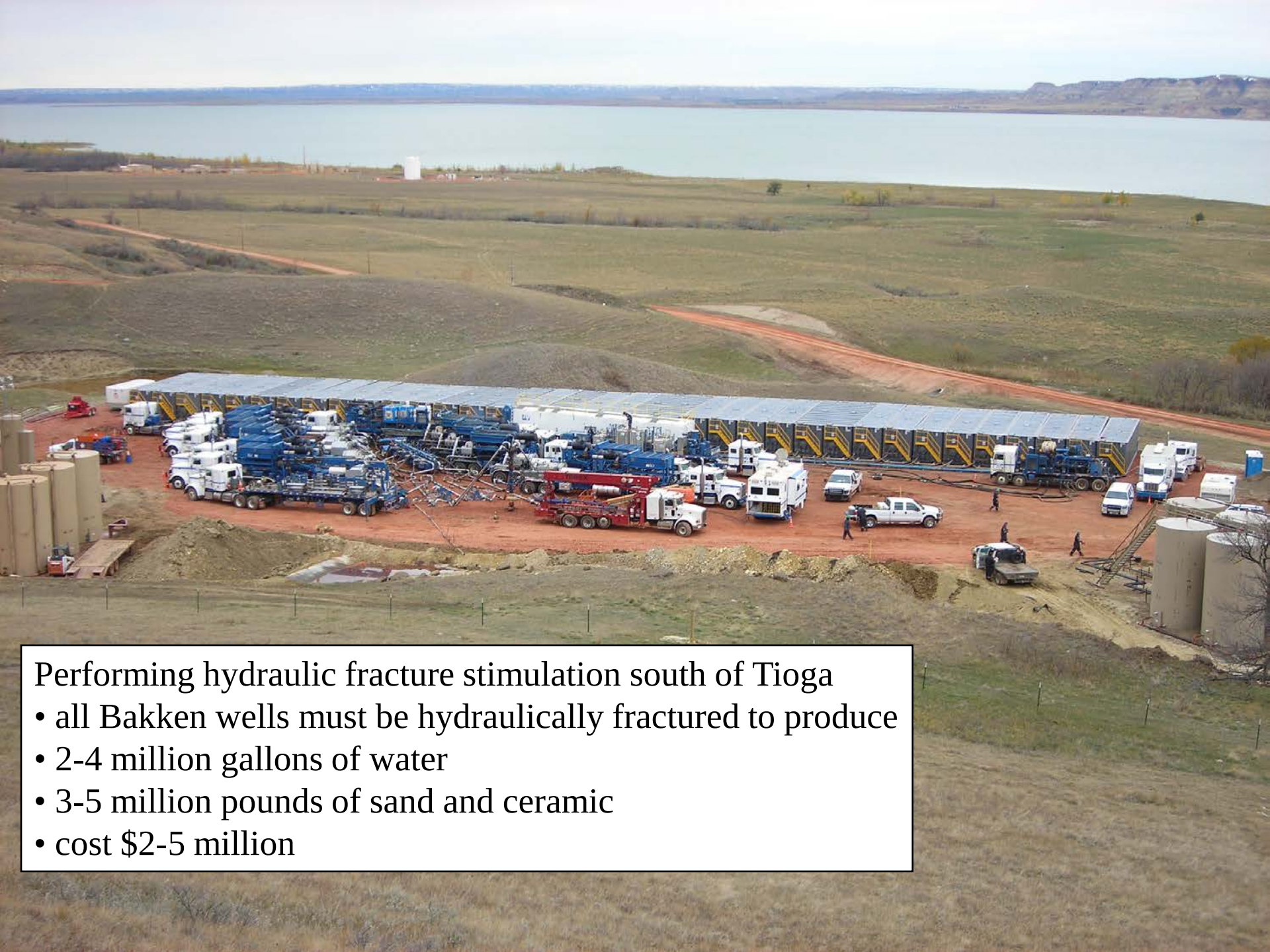
Housing and Infrastructure

Resource protection

- Ground water
- Surface water

Resource conservation

- Land and wildlife



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

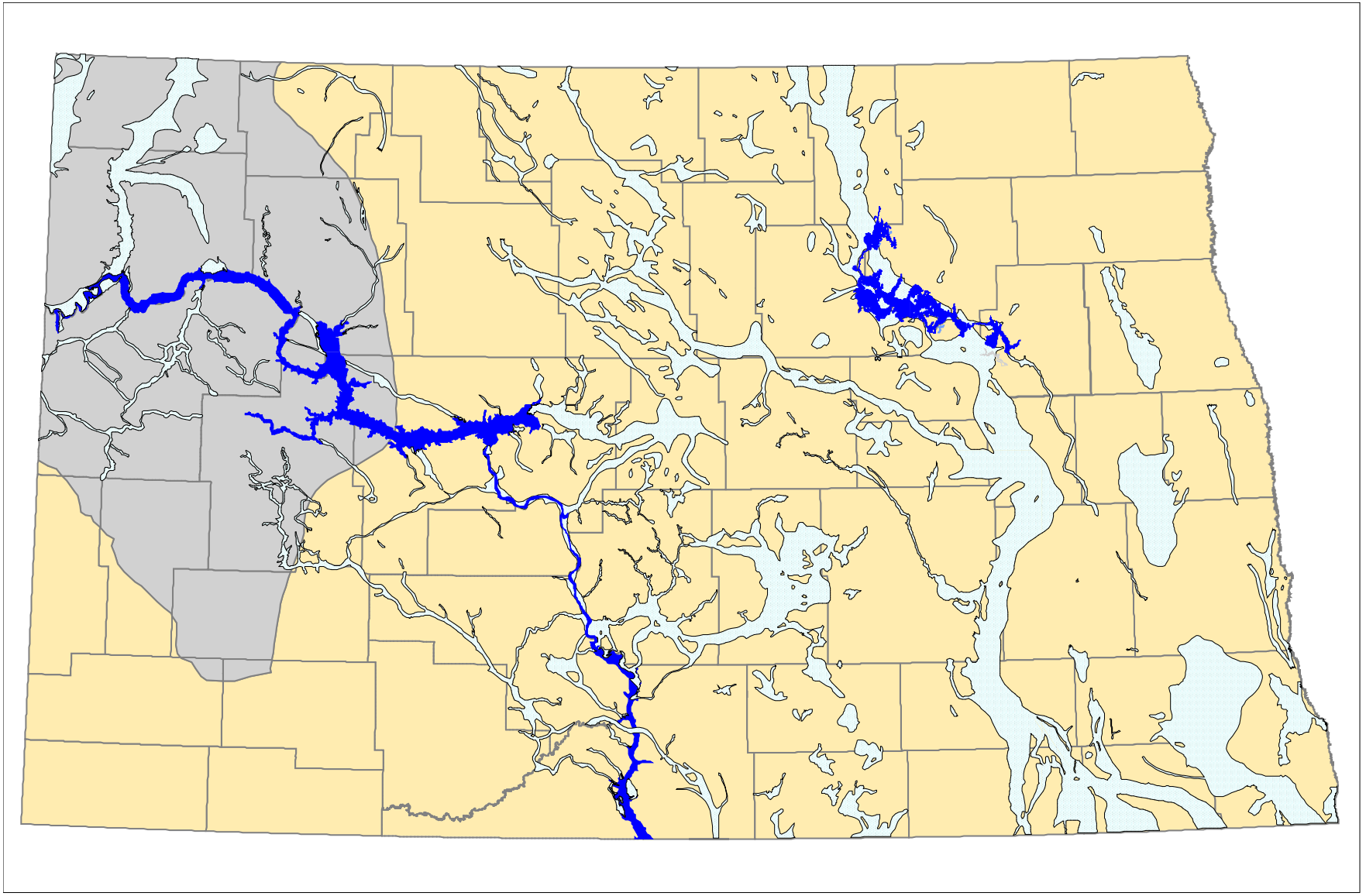
Water Commission Regulation

- Regulate water appropriations
- Guard against withdrawals exceeding recharge

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

WESTERN NORTH DAKOTA ROADS, WATER, & HOUSING

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as of April 30, 2012

(in millions)

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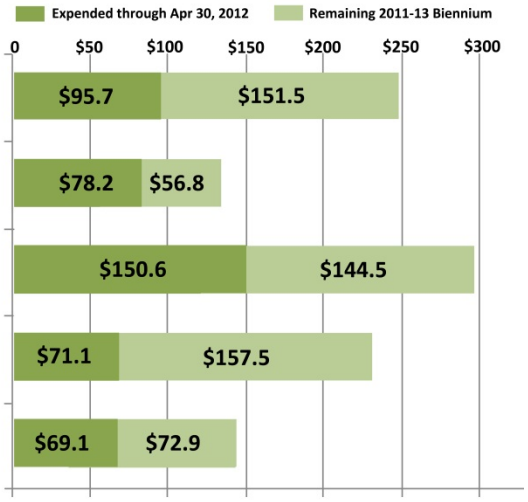

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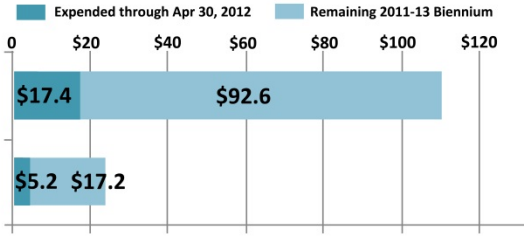

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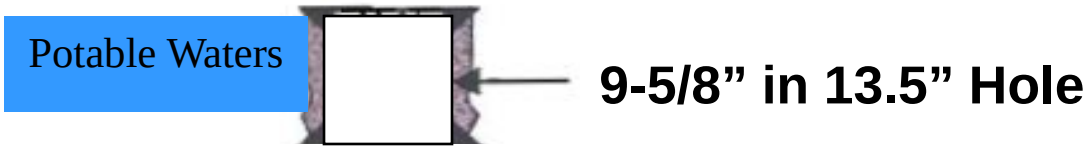
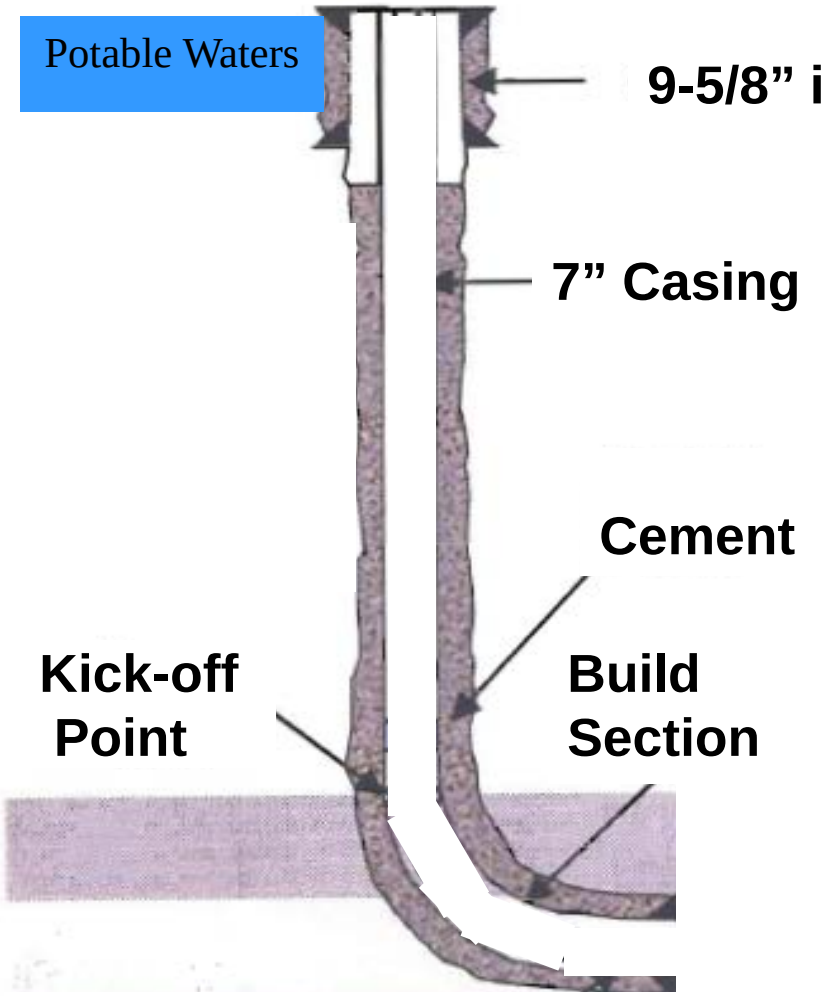
TYPICAL HORIZONTAL OIL WELL



- **Drill with fresh water = 65,000 gallons**
- **Total depth below lowest potable water**
- **Run in hole with surface casing**
- **1st layer of surface water protection**
- **Cement casing back to surface of ground = 15,000 gallons**
- **2nd layer of surface water protection**

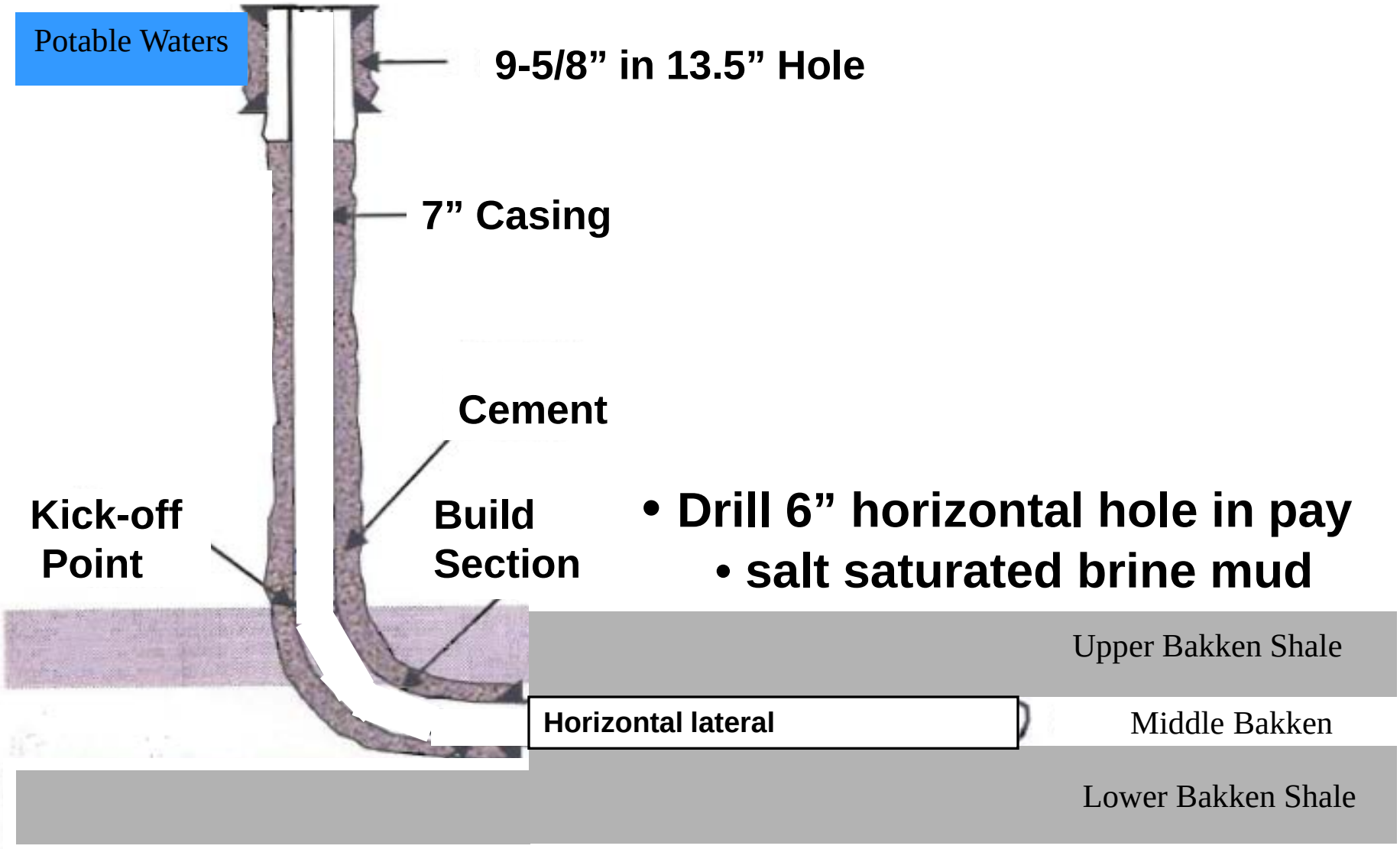
- **Total = 80,000 gal / well = 500,000 gal / day**

TYPICAL HORIZONTAL OIL WELL



- Drill 8-3/4” hole to pay
  - Diesel fuel drilling mud
- Run in hole with 7” casing
- 3rd layer of protection
- Cement 7” casing
  - 45,000 gal / well
  - 275,000 gal / day
- 4th layer of protection

TYPICAL HORIZONTAL OIL WELL



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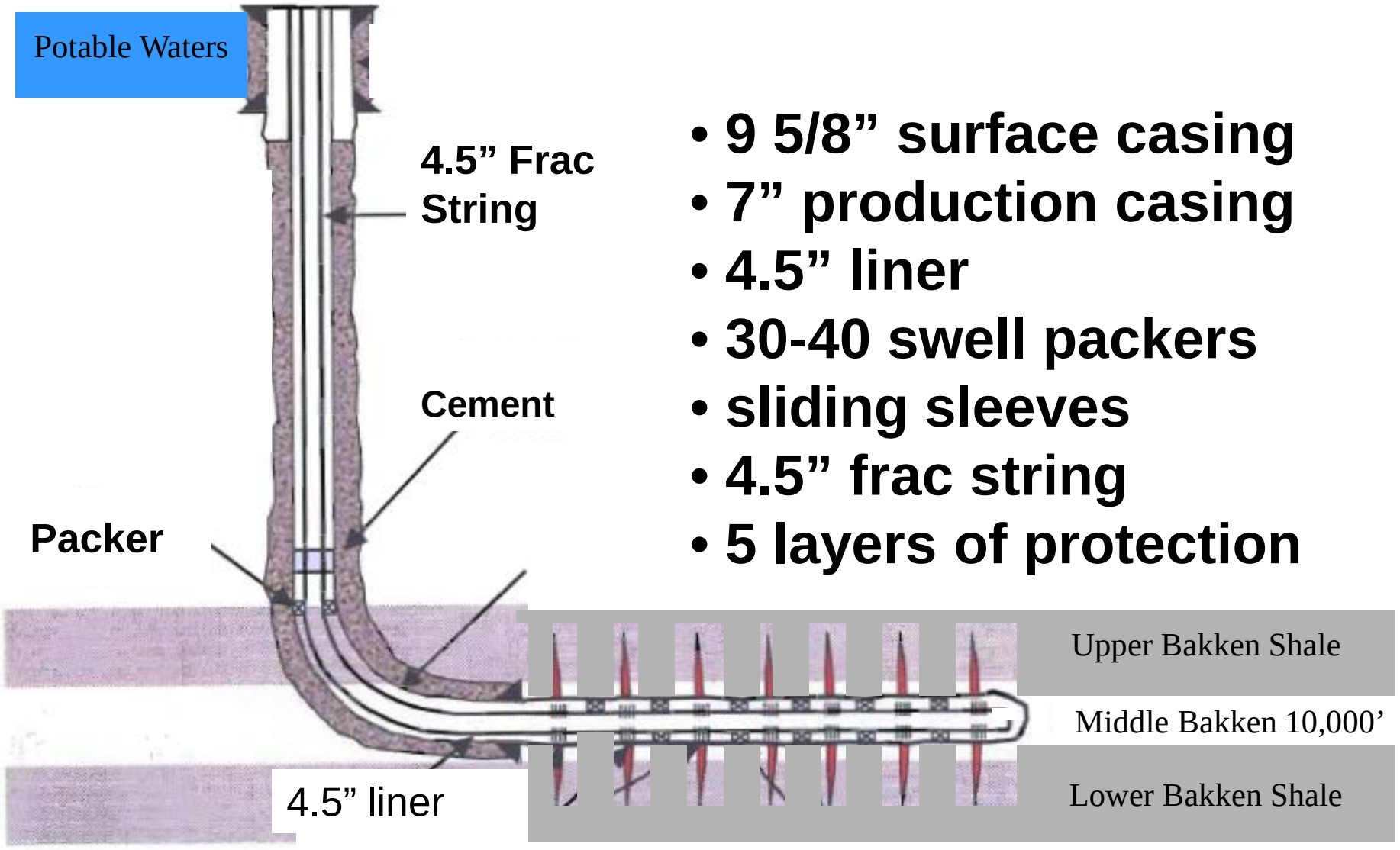
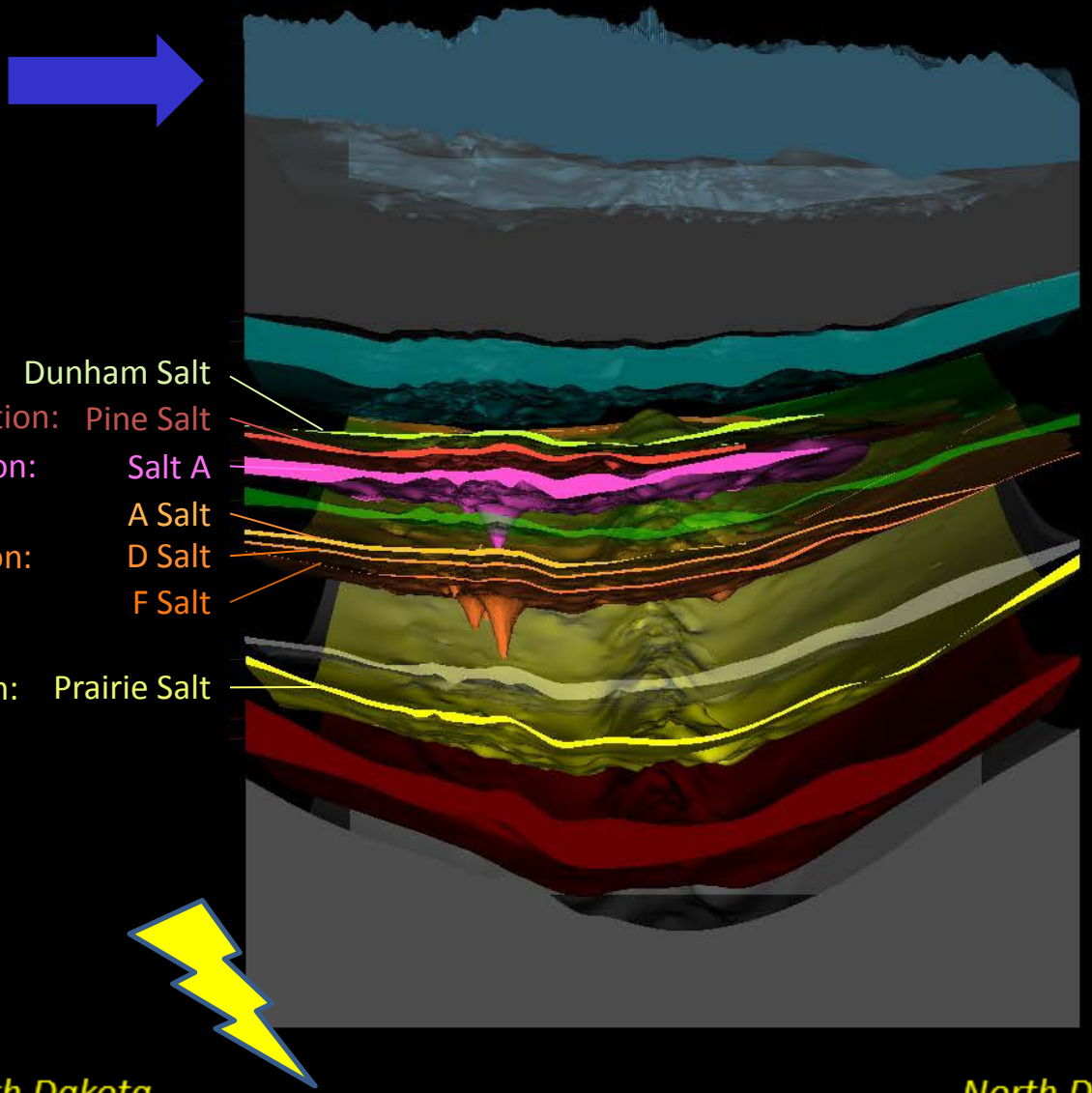


- 9 5/8” surface casing
- 7” production casing
- 4.5” liner
- 30-40 swell packers
- sliding sleeves
- 4.5” frac string
- 5 layers of protection

Industrial Commission Regulation

- Water flow back after frac
  - Storage in open pits is prohibited
  - Disposal wells are permitted through Underground Injection Program
  - Disposal zone
    - ½ mile below potable waters with impermeable shale between
    - 1-2 miles above earthquake zones with rock layers and salt beds between

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

Health Department Regulation

- Cleanup of discharge to environment
- Coordinate with local Emergency Managers
- Emergency Planning and Community Right-to-know Act (EPCRA)
- Congress passed for storing and handling of chemicals
- Requires material safety data sheet (MSDS) for each chemical on location

- **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

Hydraulic Fracturing Stimulation is Safe

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

Find a Well

Back To Search

Next Page

Page 1 of 5 Go

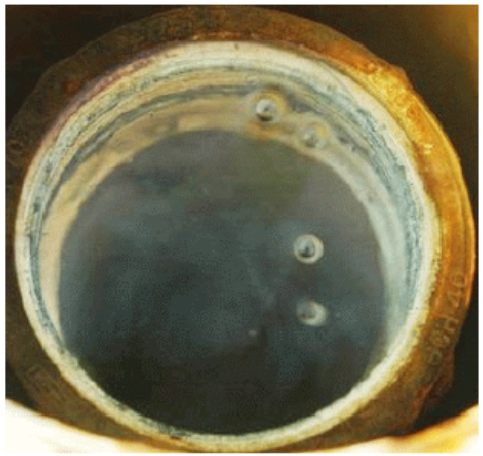
API No.	Job Date	State	County	Operator	WellName	Well Type	Latitude	Longitude	Datum
33-025-01132	4/13/2011	North Dakota	Dunn	XTO Energy/ExxonMobil	Alwin Federal 12X-19	Oil	47.627564	-102.967017	NAD83
33-105-01913	4/18/2011	North Dakota	Williams	XTO Energy/ExxonMobil	Lonnie 31X-3	Oil	48.196639	-102.880264	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

SHALLOW GAS PROJECT

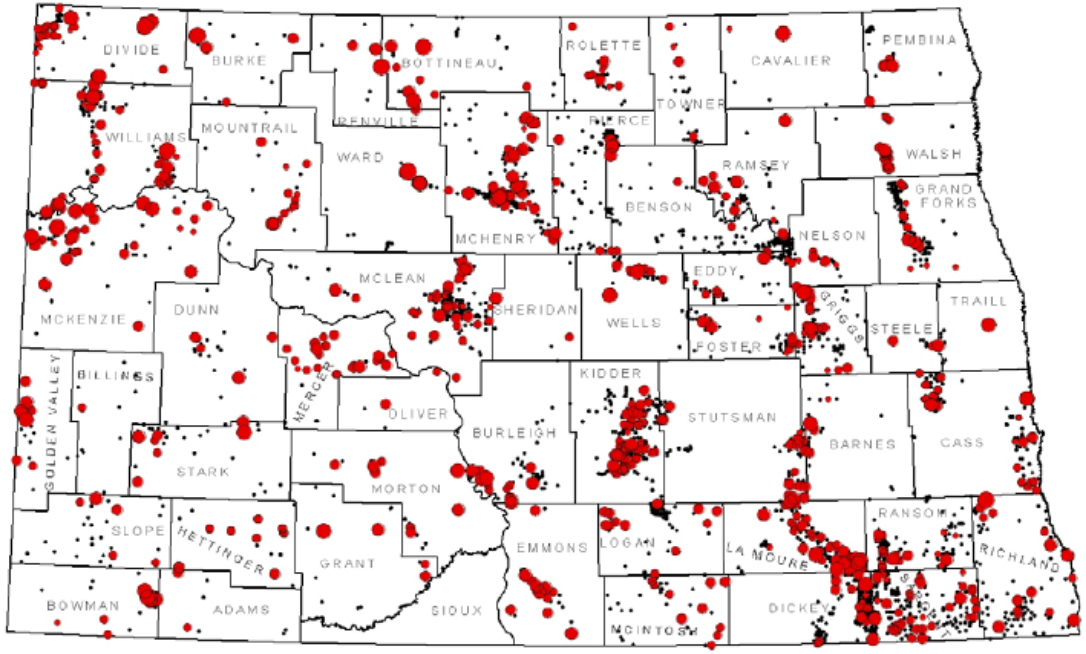
The Geological Survey tested 4,325 NDSWC monitoring wells for methane in 52 of the 53 counties in North Dakota from 2006-2010.

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.

North Dakota Challenges

Housing and Infrastructure

Resource protection

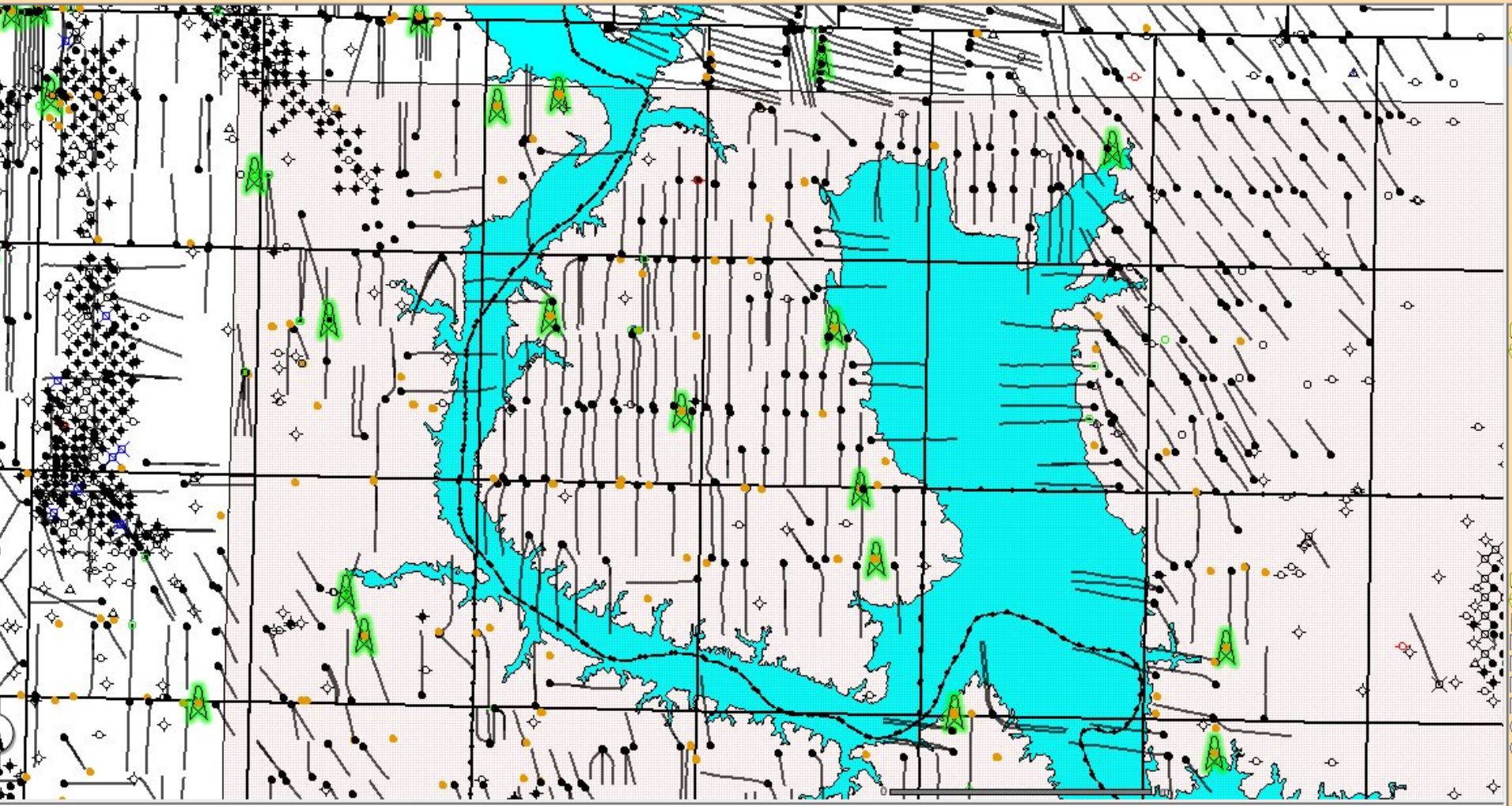
- Ground water
- Surface water

Resource conservation

- Land and wildlife

- Oil and Gas : ArcIMS Viewer - Windows Internet Explorer

ArcIMS Viewer



Sakakawea Area Spill Response

Oil, gas and pipeline companies working near the upper Missouri River and Lake Sakakawea regions has formed the Sakakawea Area Spill Response LLC (SASR). The purpose of SASR is to provide resources to assist members in responding quickly and comprehensively to an open water spill as a way to minimize impacts and protect residents and the environment.

Members of SASR have agreed to share and deploy existing emergency-response and spill-containment equipment and other resources in the event of a spill. SASR also plans to buy and maintain additional equipment that would be available to member companies during an incident response.

SASR is a volunteer effort. The committee is currently looking for locations to park the equipment, a third-party contractor to maintain and deploy the equipment, and more members. To date, seven companies are members of SASR: Bridger Pipeline, Enbridge Pipelines (ND), Hess, Marathon Oil Co., Slawson Exploration, Whiting Petroleum and WPX Energy Williston, LLC.

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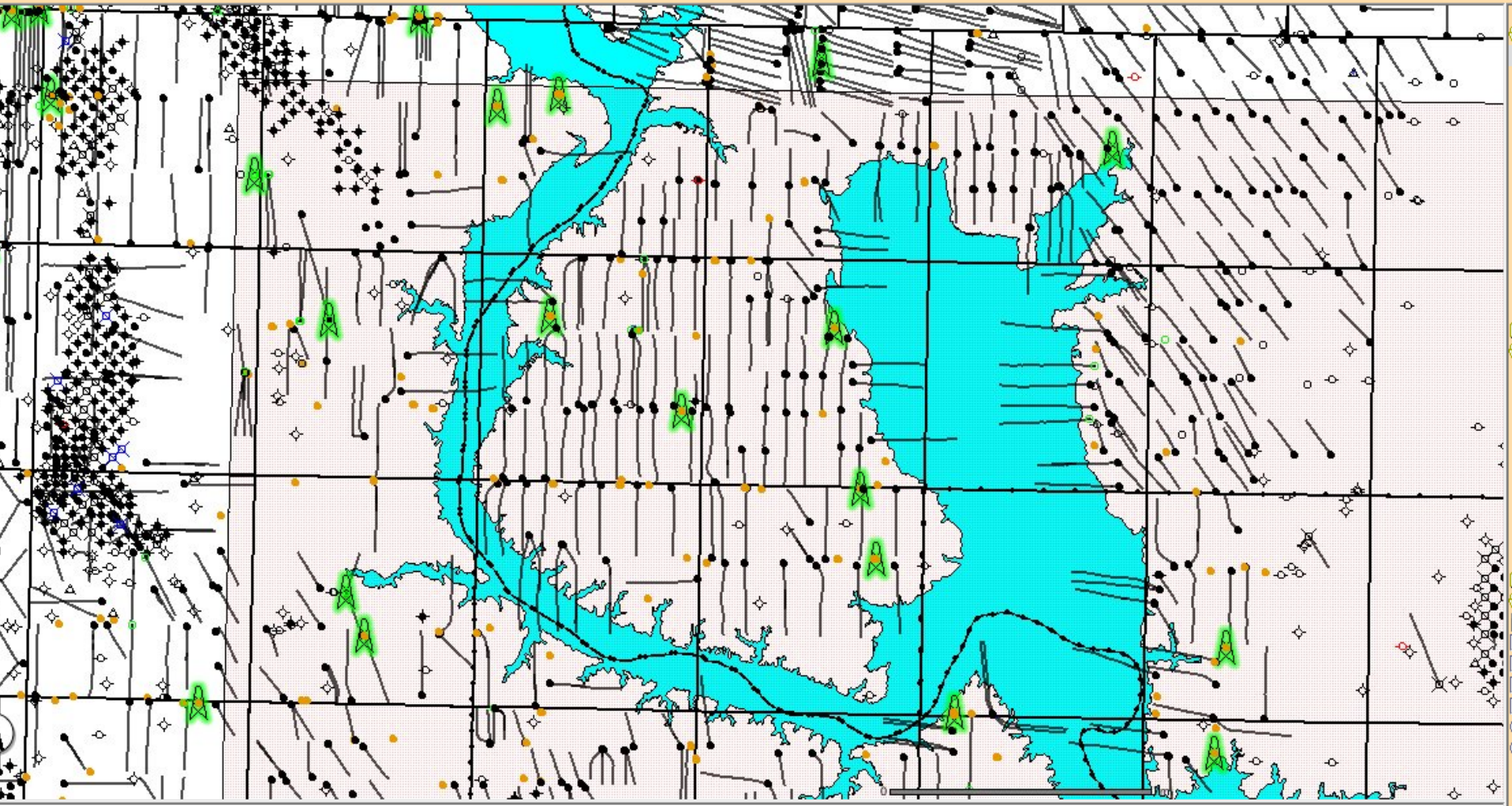
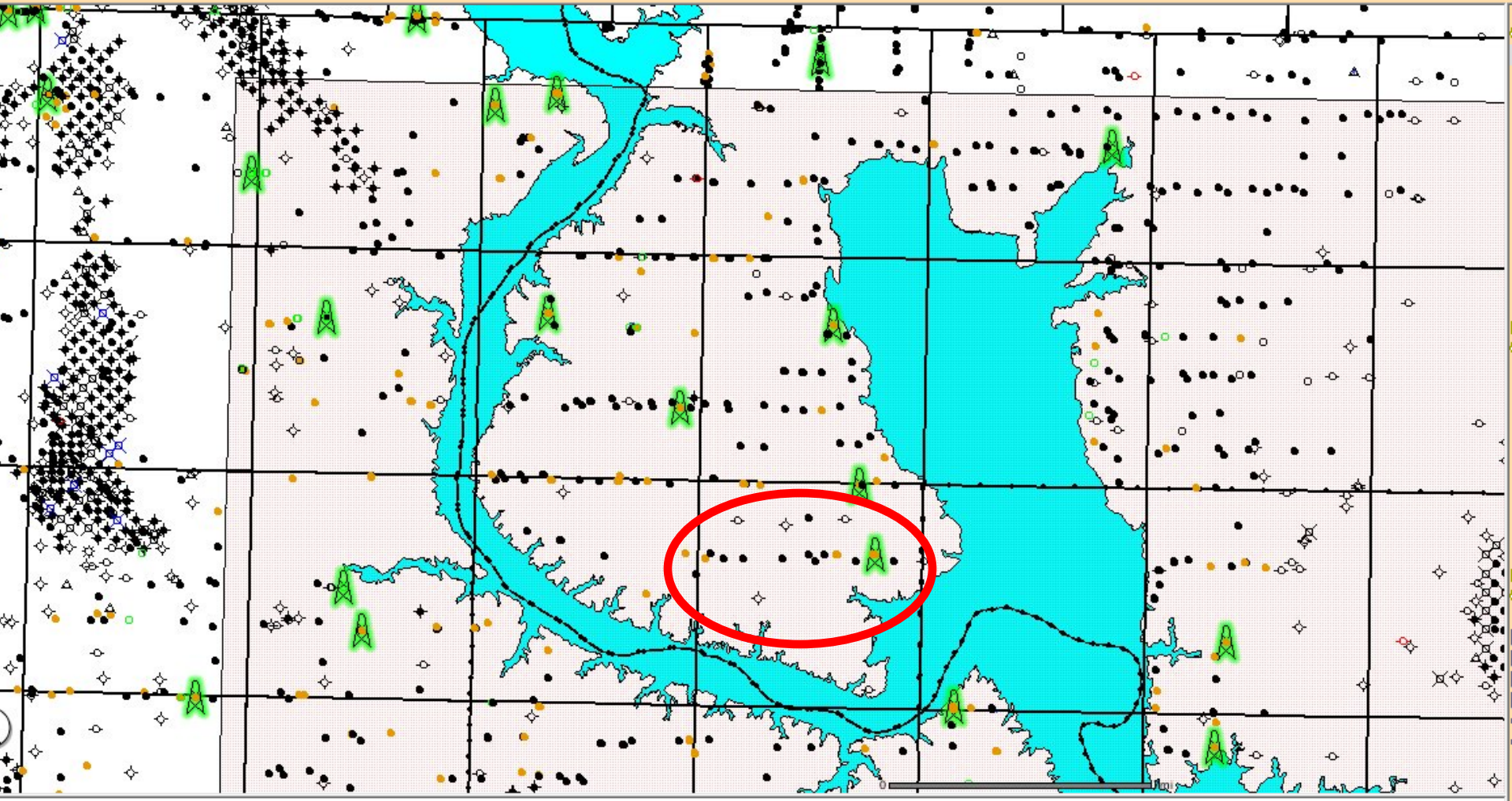
- Oil and Gas : ArcIMS Viewer - Windows Internet Explorer

ArcIMS Viewer



- Oil and Gas : ArcIMS Viewer - Windows Internet Explorer

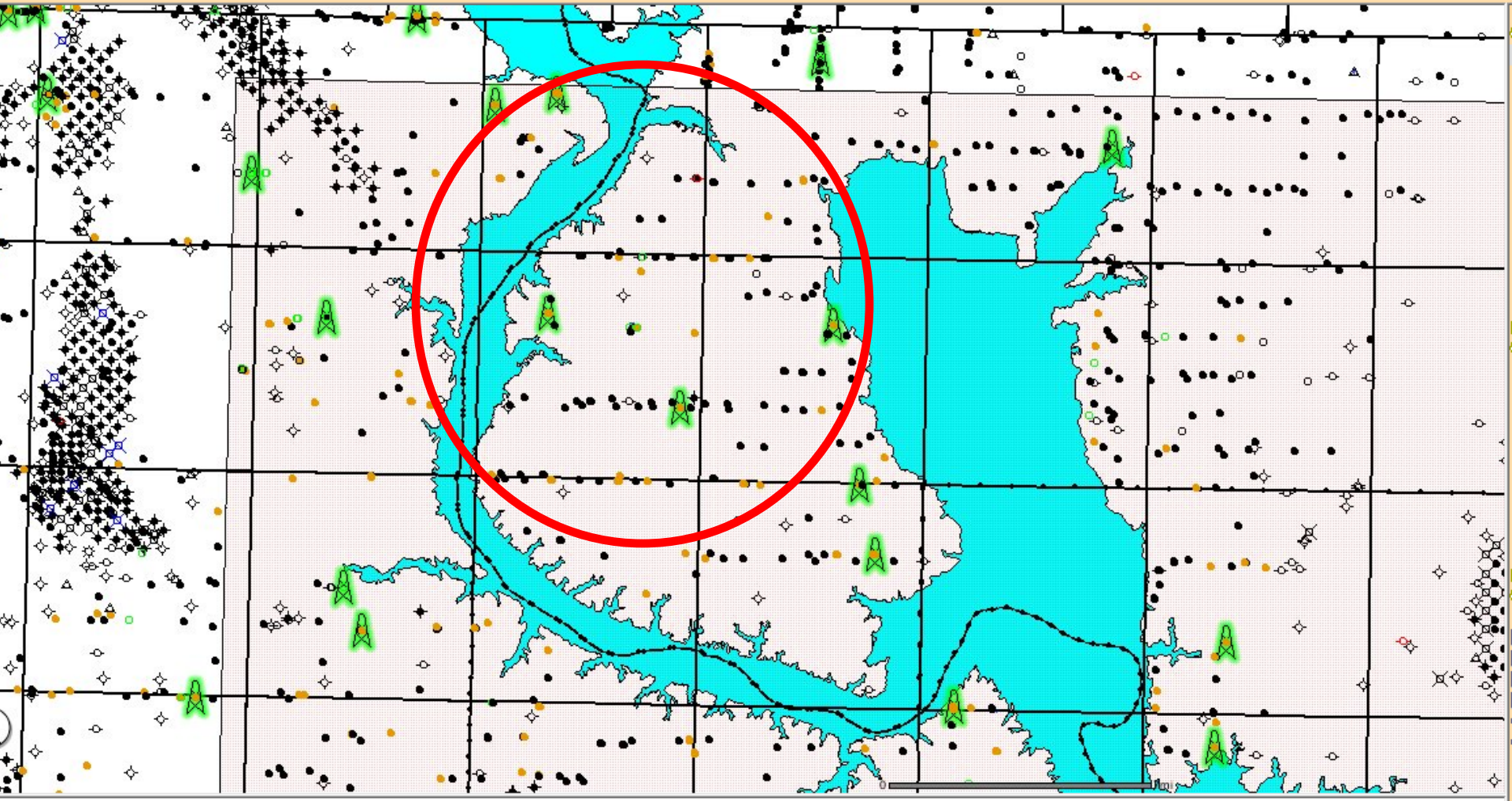
ArcIMS Viewer

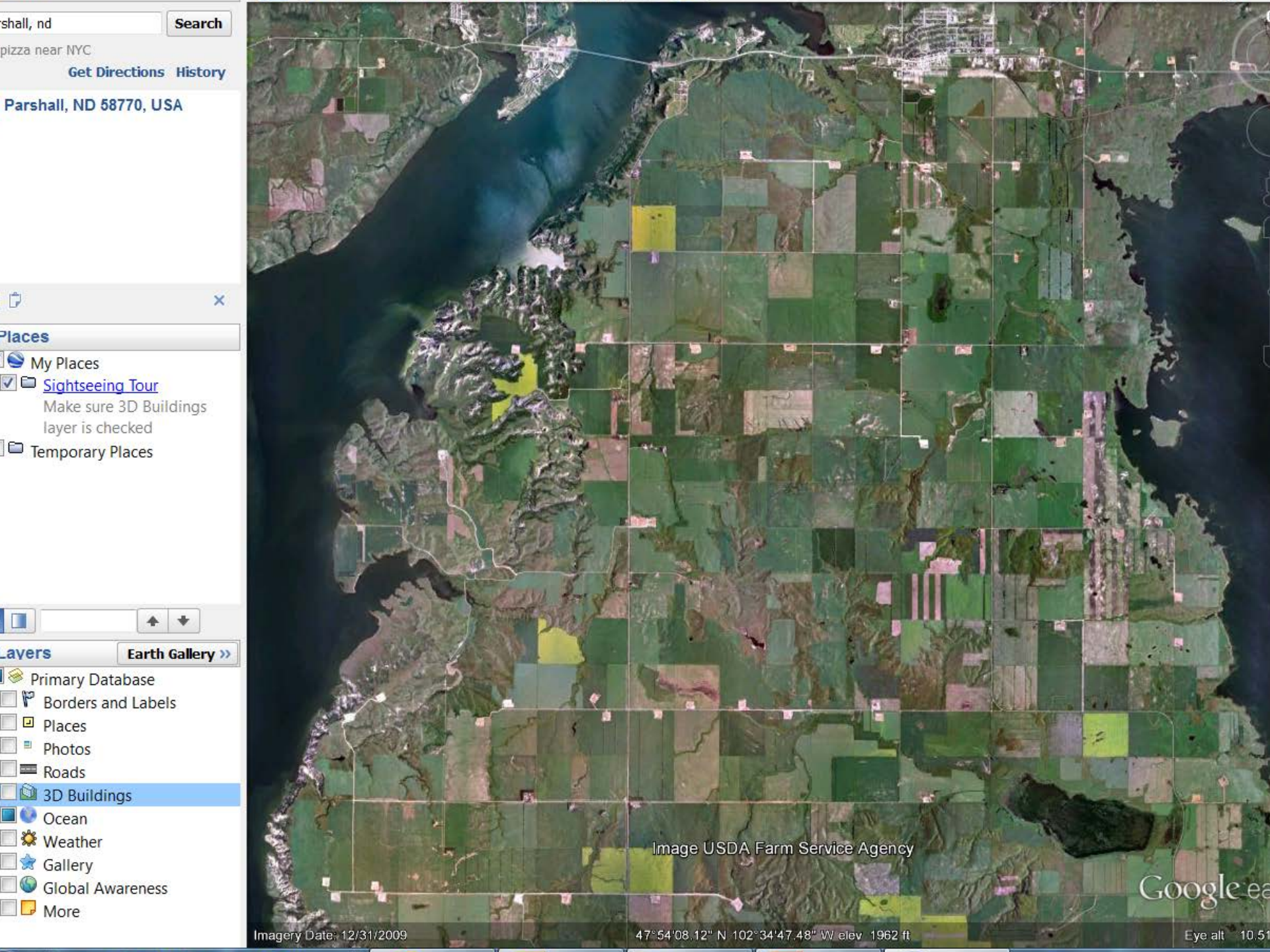


Vern Whitten Photography

- Oil and Gas : ArcIMS Viewer - Windows Internet Explorer

ArcIMS Viewer

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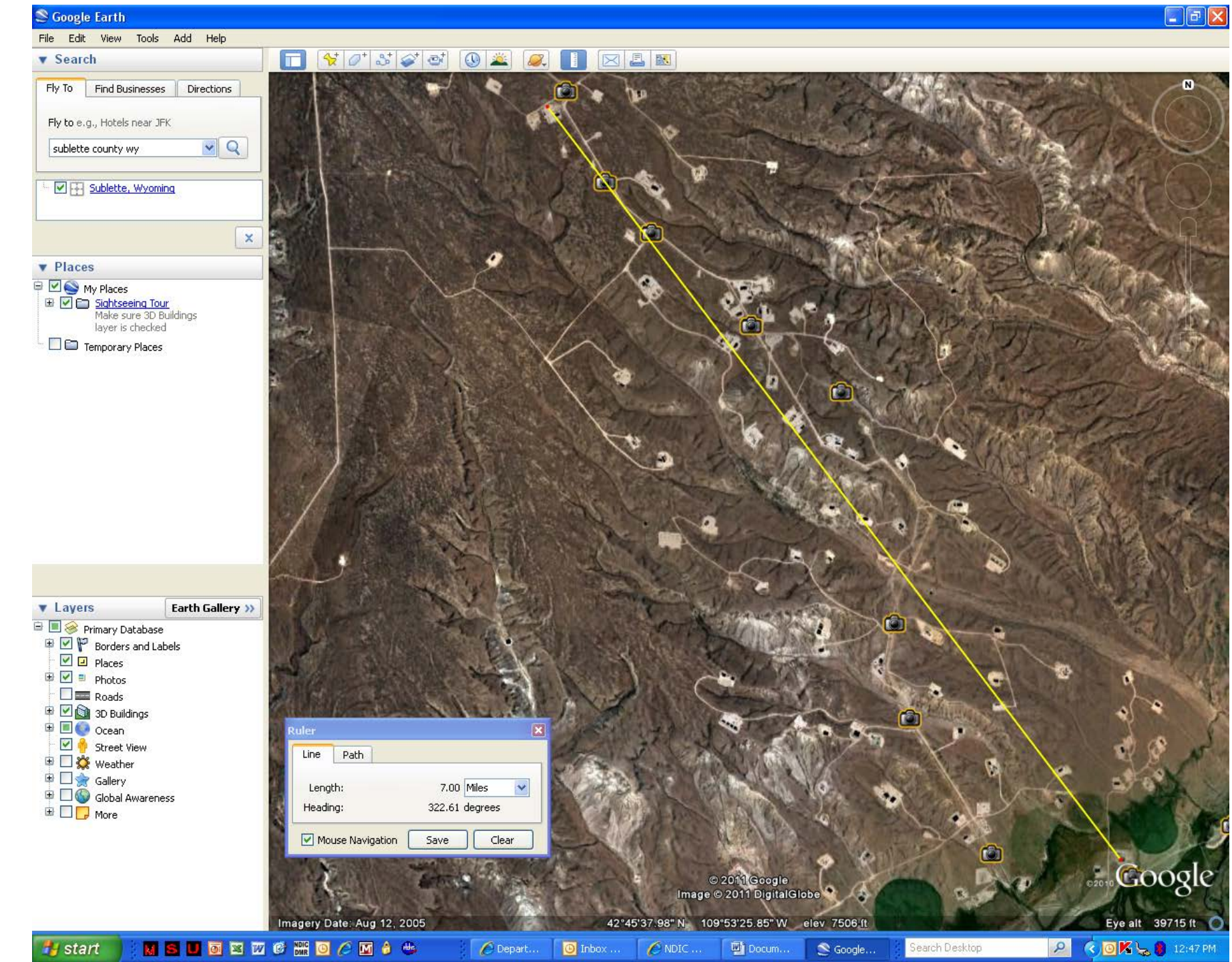
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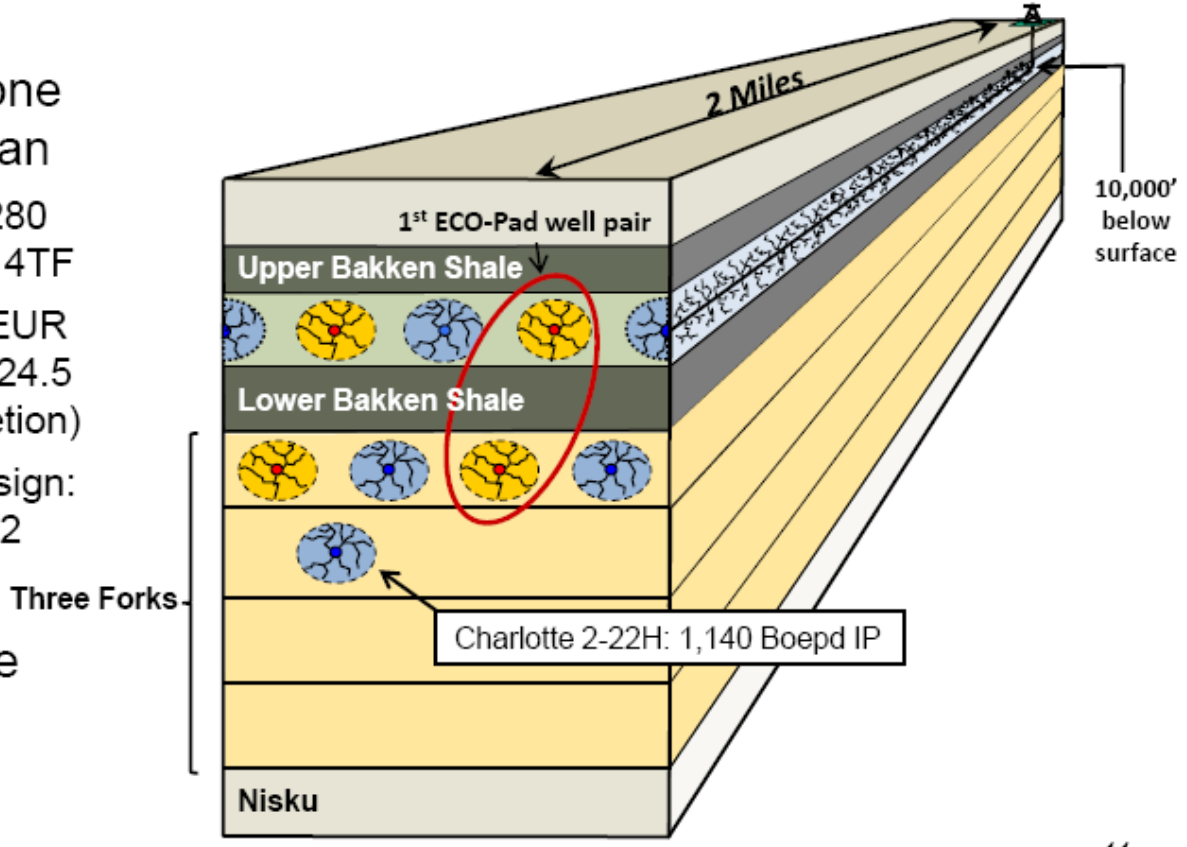
Bakken Development Plan

- 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

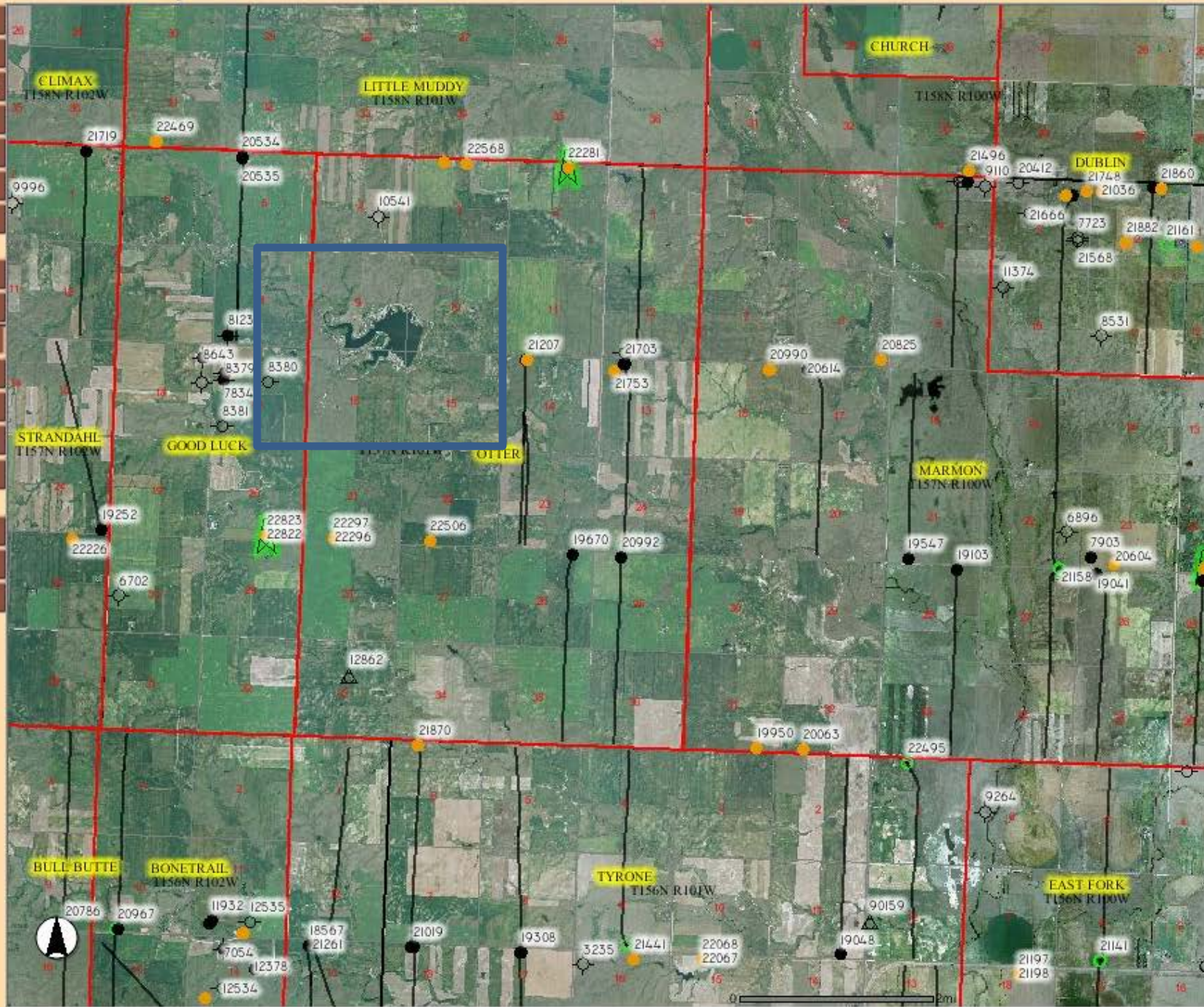
Vern Whitten Photography

Oil and Gas Subscription: ArcIMS Viewer

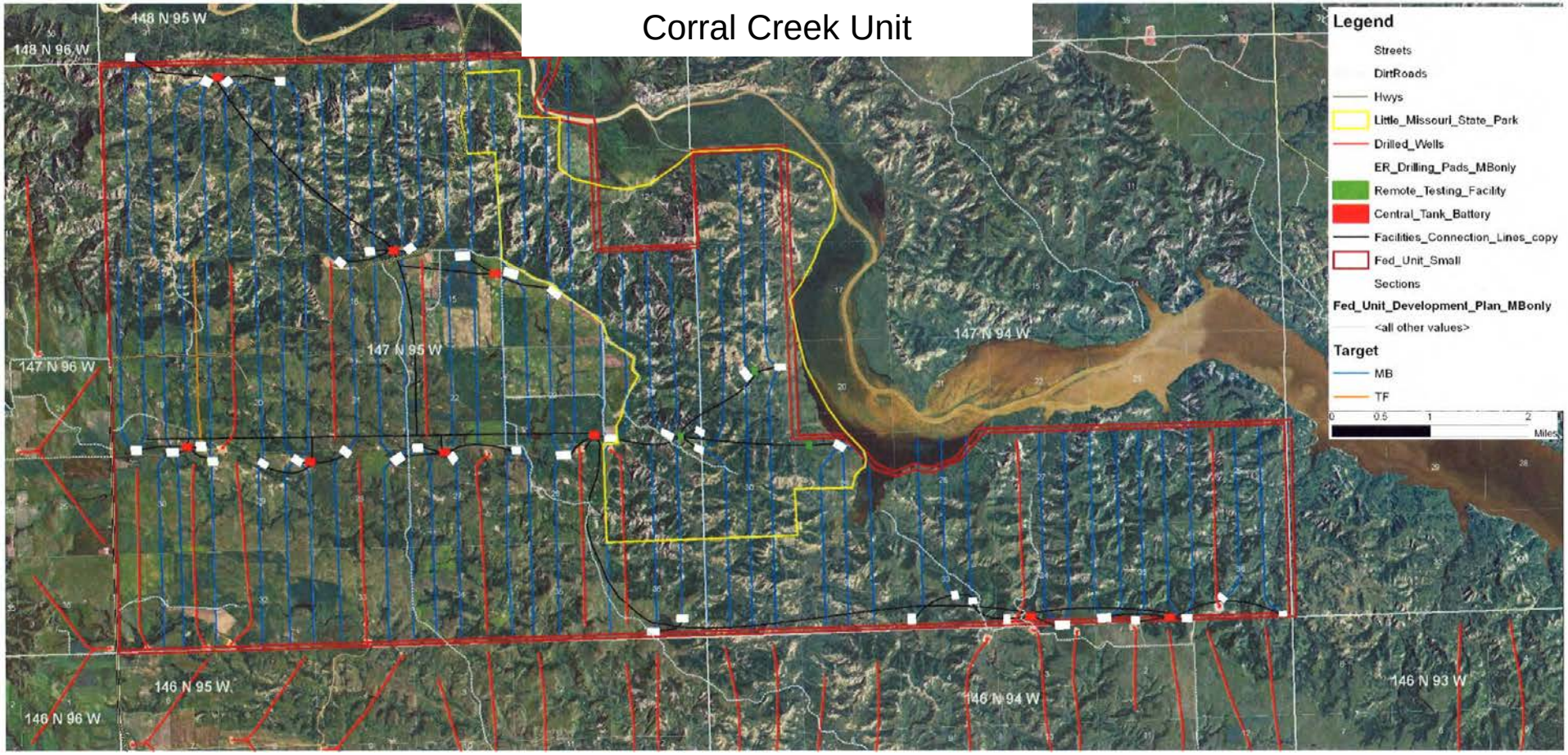
- Legend / Layers
- Overview Map
- View Entire State
- Previous View
- Clear Selection
- Search
- Generate PDF

- Zoom In
- Zoom Out
- Pan
- Rect Identify
- Select Object
- Buffer
- Distance

- Find Well
- Find Field/Unit
- Find Section

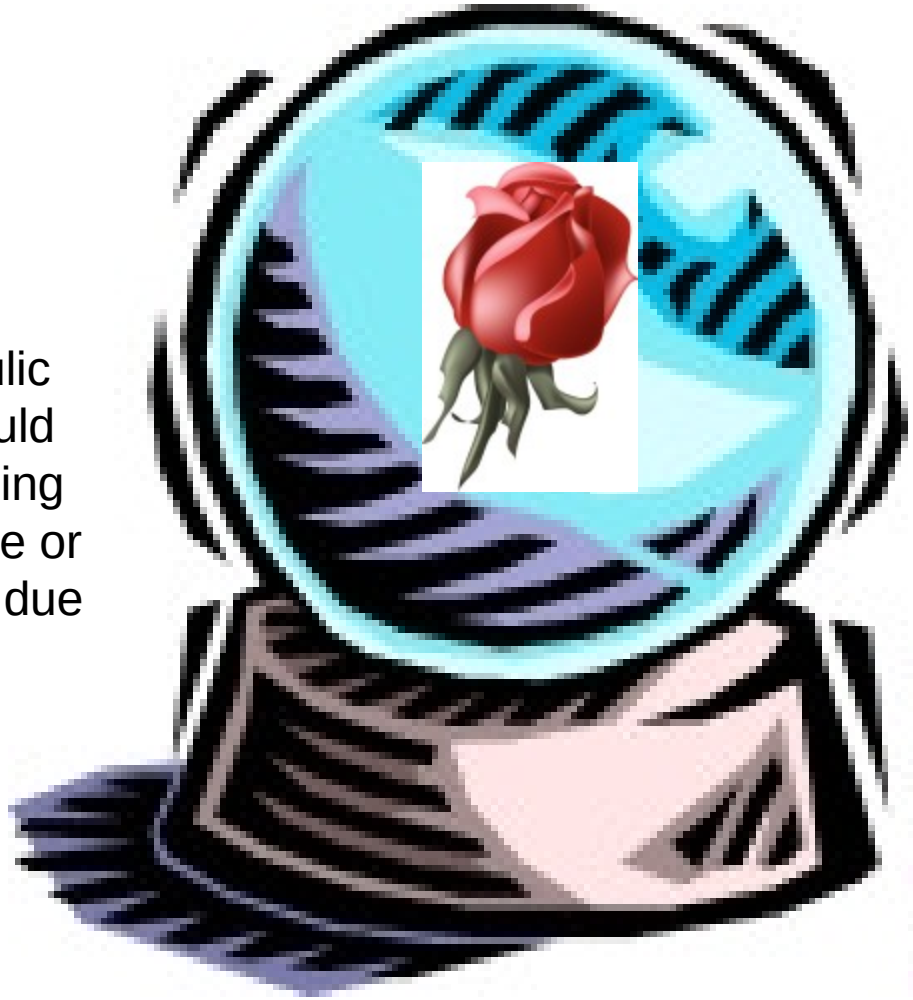


Corral Creek Unit



Draft BLM Hydraulic Fracturing rule could double federal drilling permit approval time or worse. Comments due 7/10/12

Current administration budget contains tax changes that could reduce drilling capital 35-50%

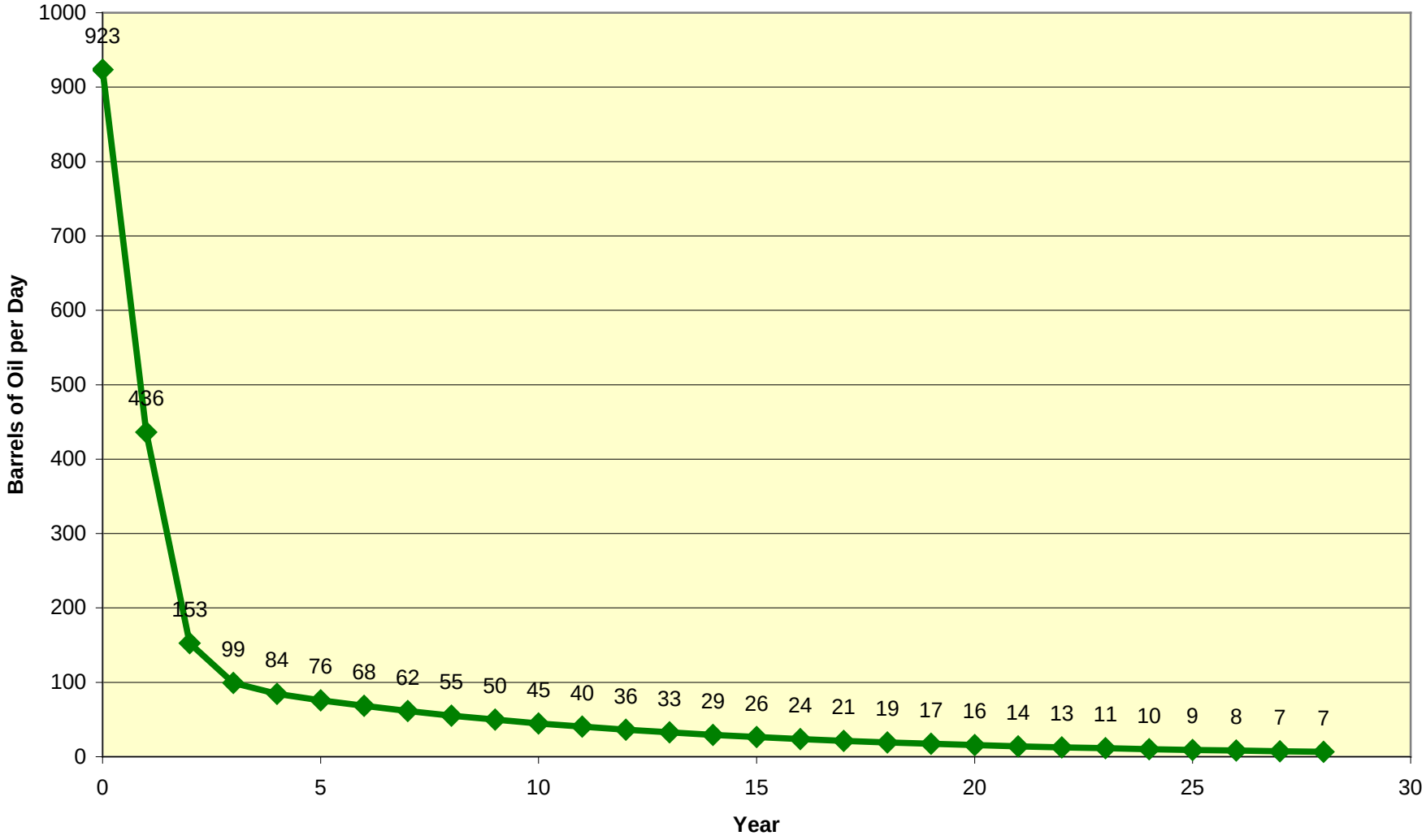


The future looks promising for sustained Bakken/Three Forks development

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

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

Typical Bakken Well Production



What Does Every New Bakken Well Mean to North Dakota

A typical 2011 North Dakota Bakken well will produce for 29 years

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

In those 29 years the average 2011 Bakken well will:

Produce approximately 540,000 barrels of oil

Generate over $20 million net profit

Pay approximately $4,585,000 in taxes
- $2,200,000 gross production taxes
- $2,000,000 extraction tax
- $385,000 sales tax

Pay royalties of $7,500,000 to mineral owners

Pay salaries and wages of $2,100,000

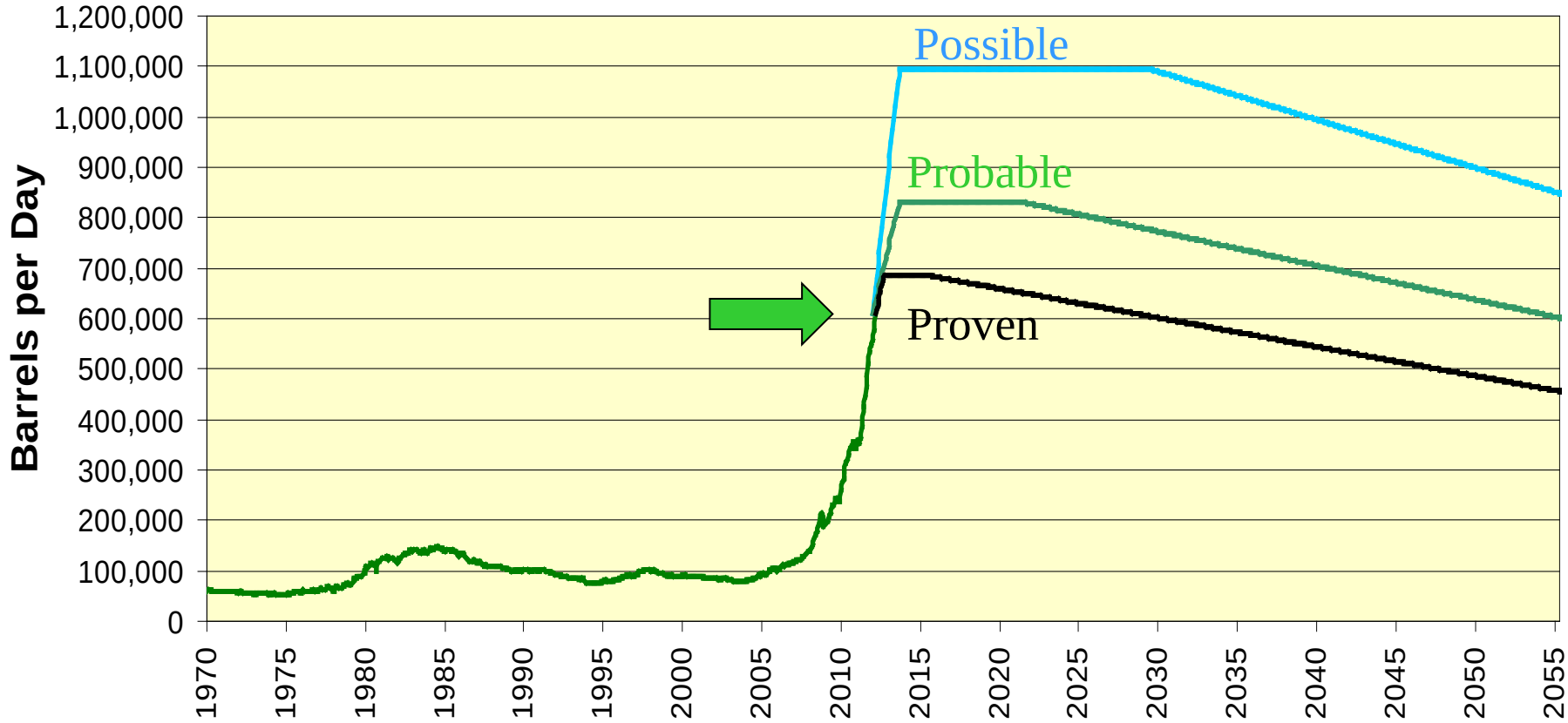
Pay operating expenses of $2,300,000

Cost $7,925,000 to drill and complete

Western North Dakota

- 1,100 to 2,700 wells/year = 2,000 expected
  - 100-225 rigs = 12,000 – 27,000 jobs
  - Another 10,000-15,000 jobs building infrastructure
  - 225 rigs can drill the wells needed to secure leases in 2 years
  - 225 rigs can drill the wells needed to develop spacing units in 16 years
  - 35,000-40,000 new wells = 45,000-50,000 long term jobs

North Dakota Oil Production



3,670 **Bakken and Three Forks wells drilled and completed**

36,000 **more new wells possible in thermal mature area**

Proven=7 BBO – Probable=10 BBO – Possible=14 BBO (billion barrels of oil)