

# **Horizontal Drilling in a “non-Shale” Oil Bearing Formation**

**Kentucky Oil and Gas Association**

**June 17, 2010**

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*“Horizontal Well – Easy word to say, hard word to do!”*

- Jim Rode, Fall 2007

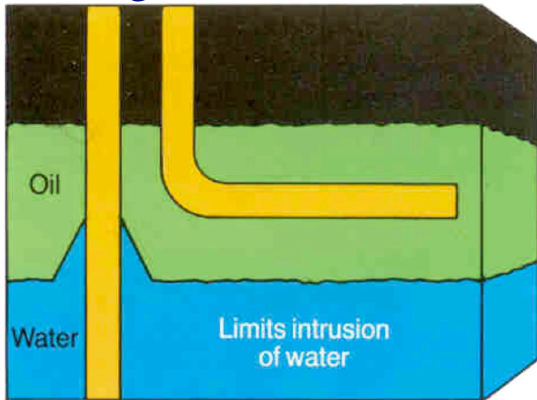
1. Selecting a Target
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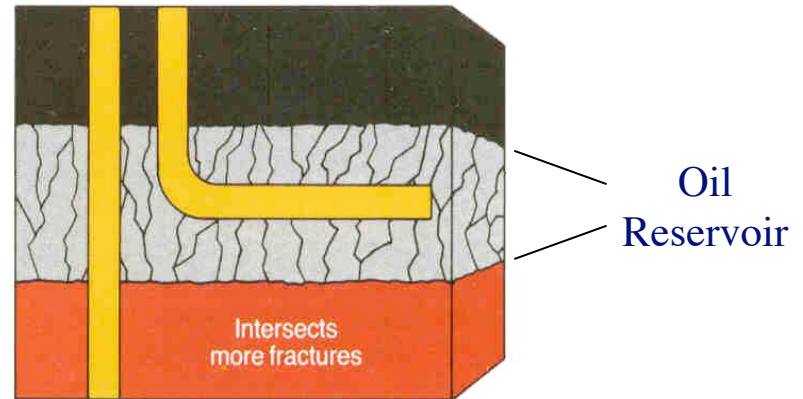


# Selecting a Target

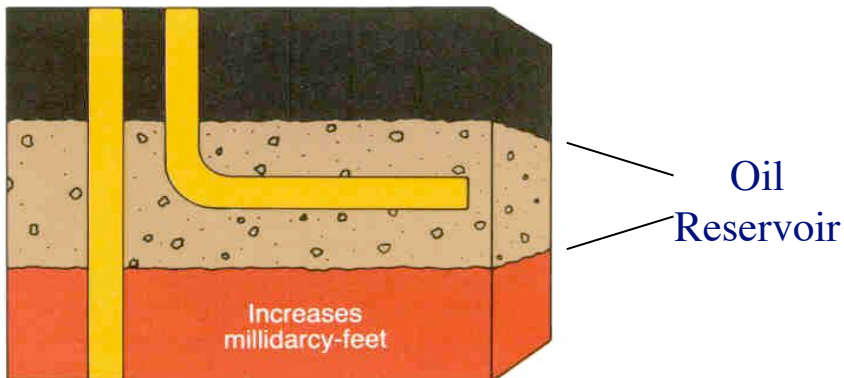
### Coning Reservoirs



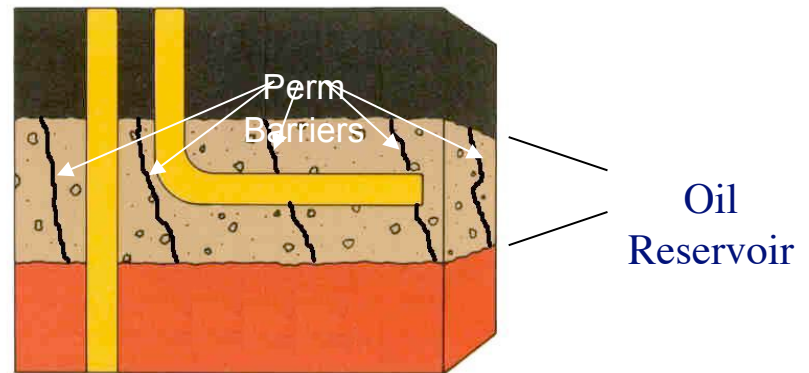
### Fractured Reservoirs



### Low Permeability Reservoirs

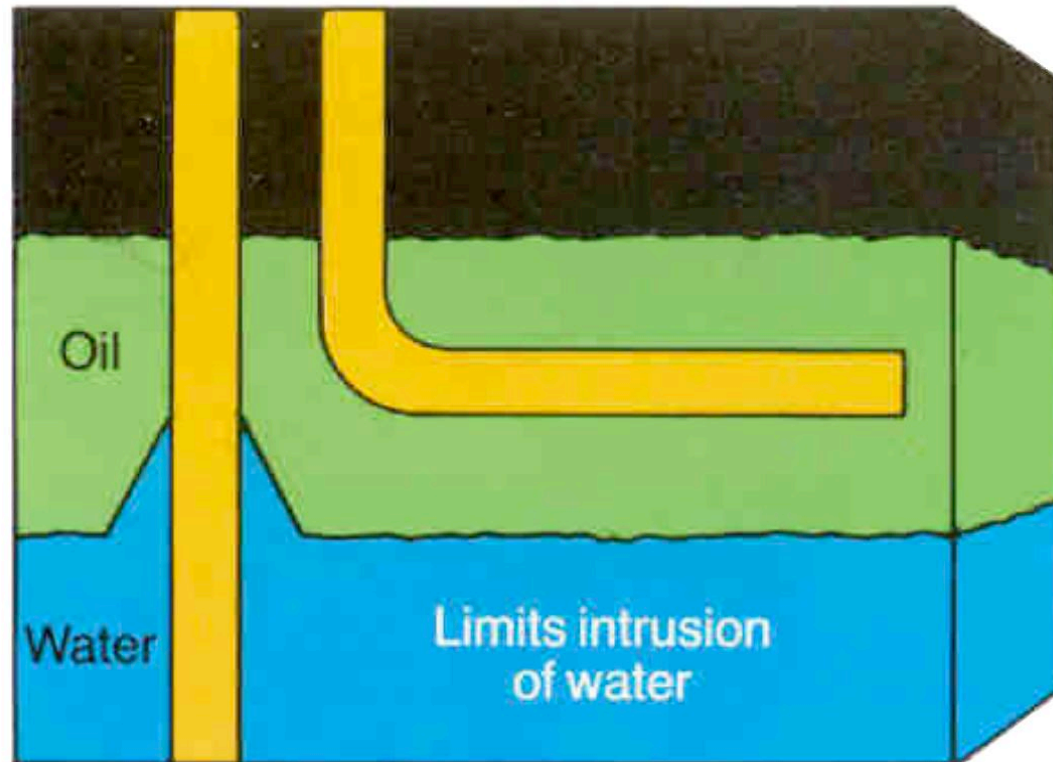


### Compartmentalized Reservoirs



# Coning Reservoirs

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# Illinois Basin Hz Coning Applications

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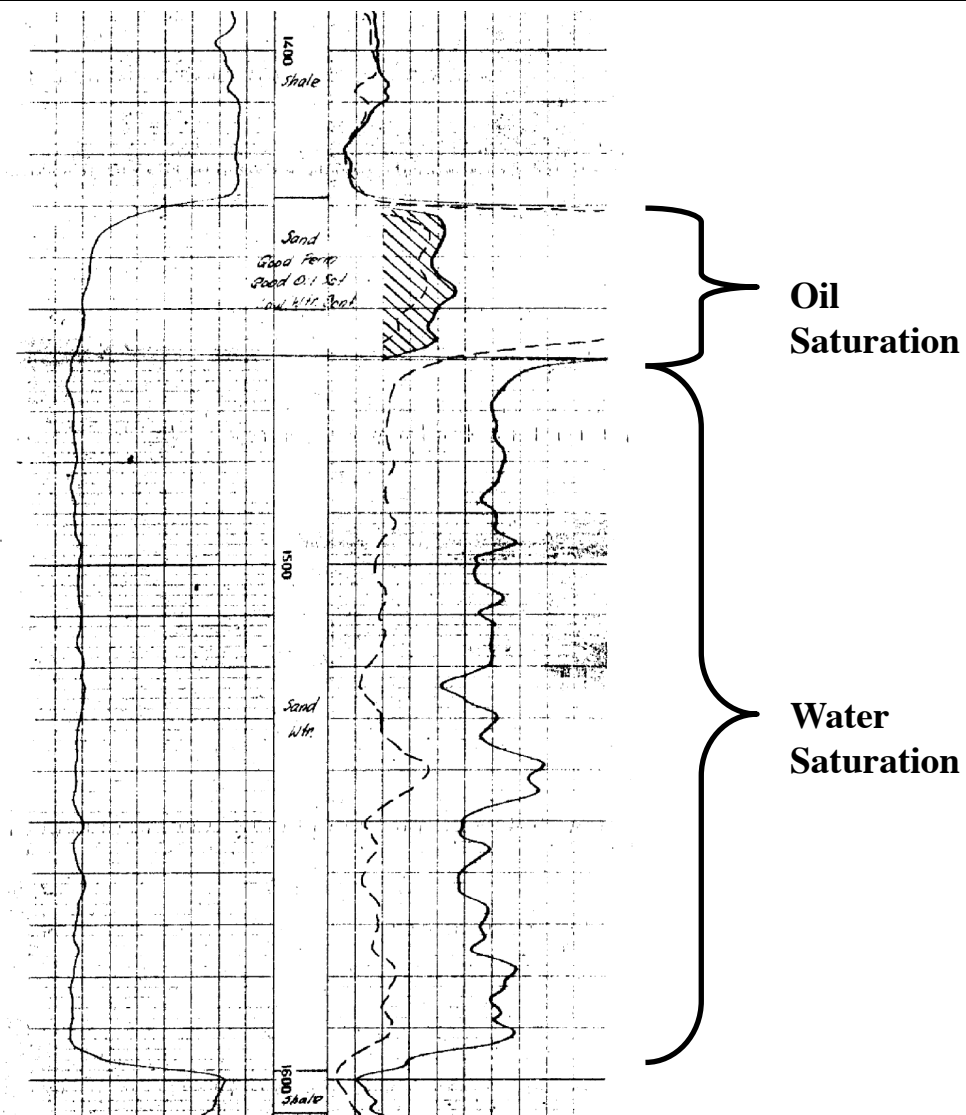
## Tested

- § Pennsylvanian Sands
- § Waltersburg Sandstone
- § Tar Springs Sandstone
- § Hardinsburg Sandstone
- § Cypress Sandstone
- § Devonian Limestone

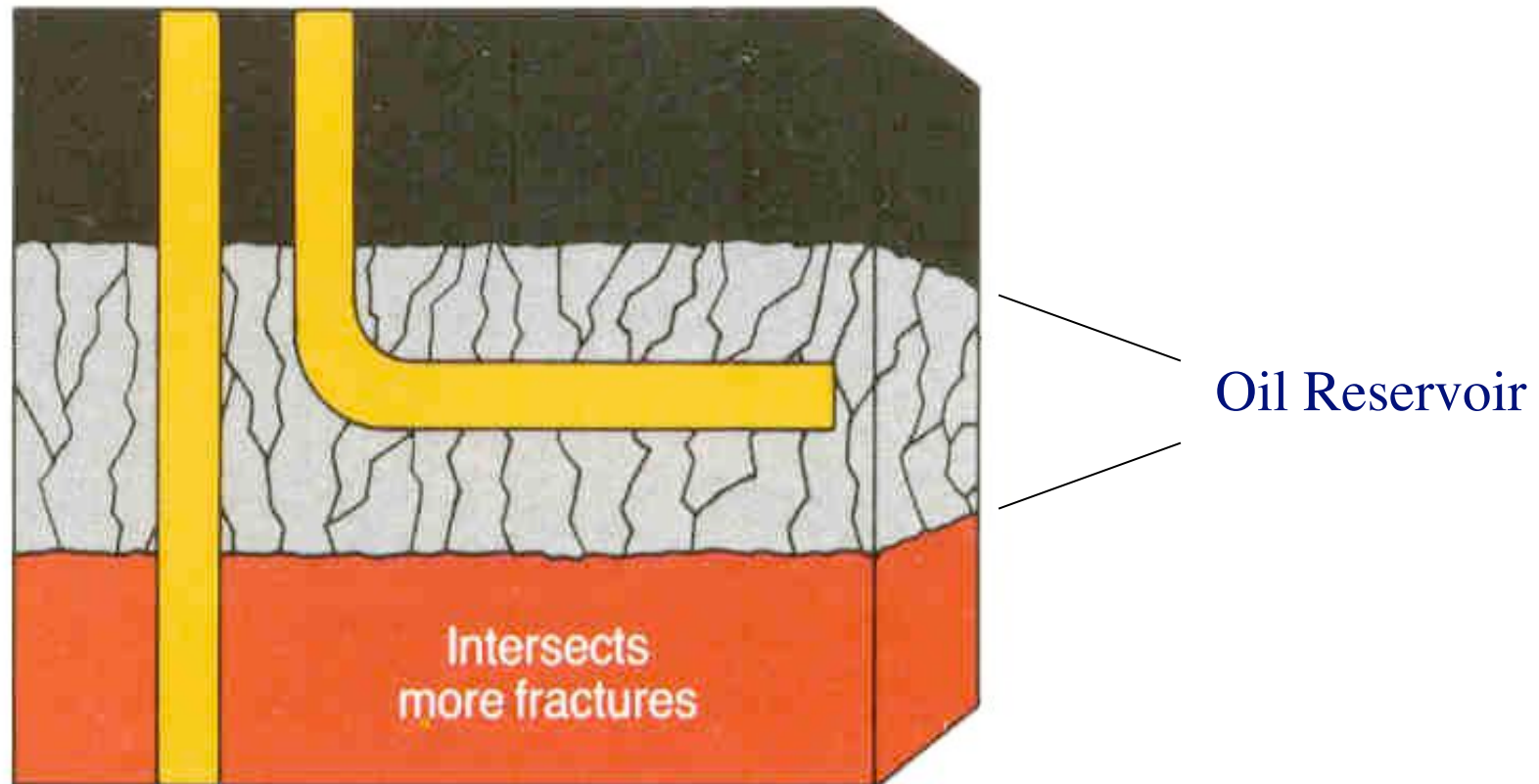
## Untested

- § Benoist Sandstone
- § Salem Limestone
- § Warsaw Limestone
- § Dutch Creek Sandstone

# Type Log – Illinois Basin Coning Target



# Fractured Reservoirs



# Illinois Basin Hz Fracture Applications

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## Tested

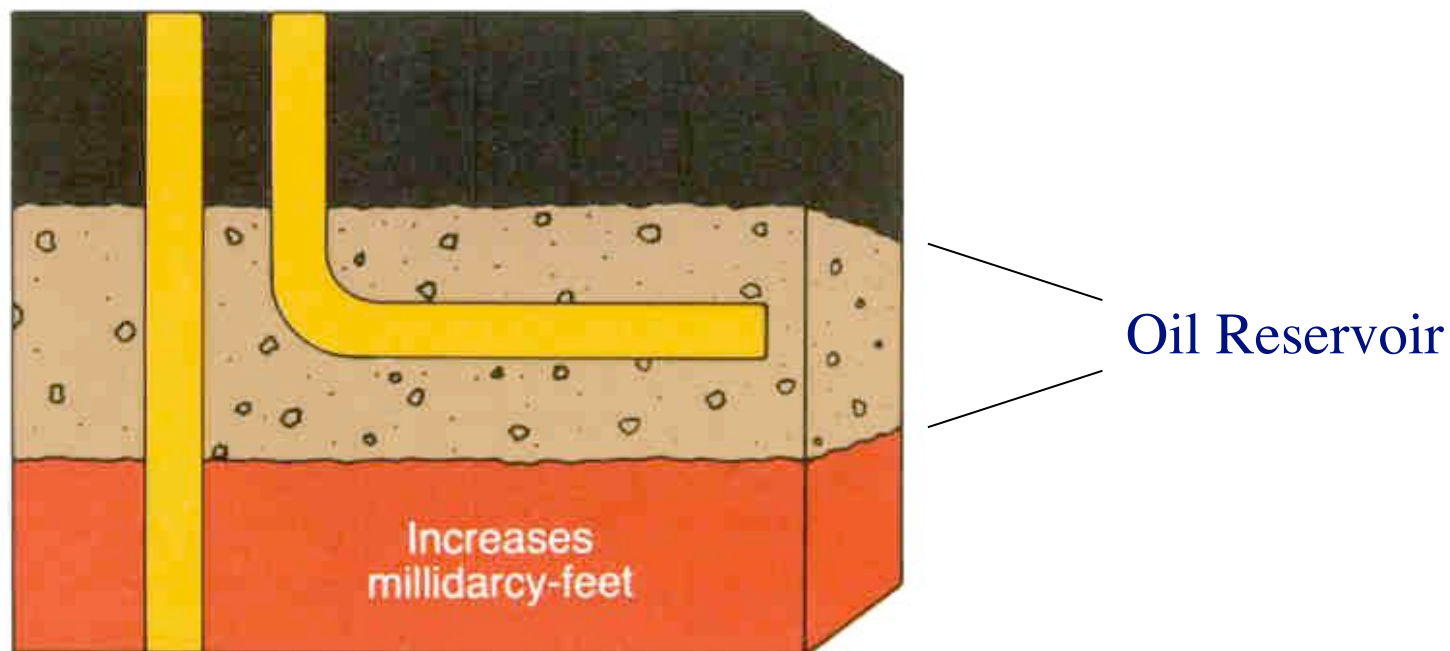
- § New Albany Shale
- § Clear Creek Limestone
- § Trenton Limestone
- § Fort Payne Limestone

## Untested

- § Kincaid Limestone
- § Louisville Limestone
- § Knox Limestone

# Low Permeability Reservoirs

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# Illinois Basin Hz Low Perm Applications

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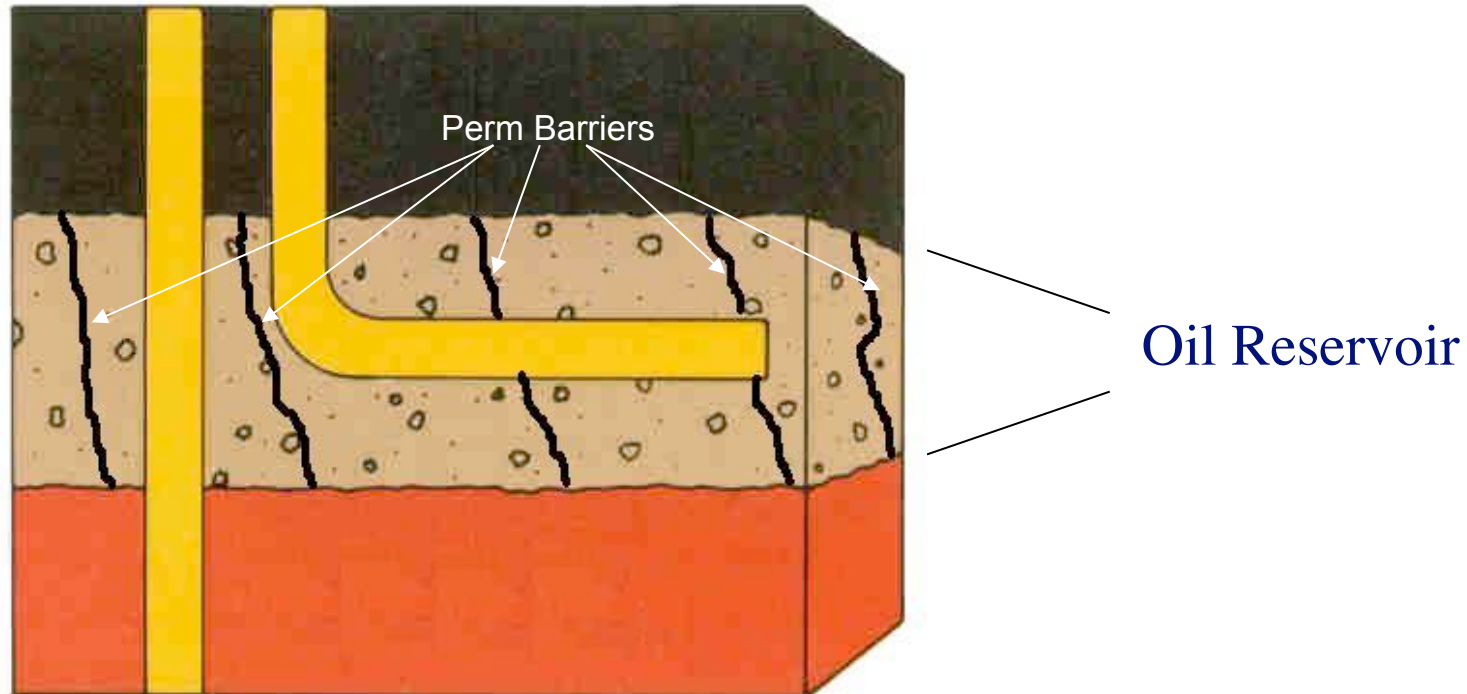
## Tested

- § Pennsylvanian Sands
- § Waltersburg Sandstone
- § McClosky Limestone
- § Devonian Limestone

## Untested

- § Tar Springs Sandstone
- § Cypress Sandstone
- § Benoist Sandstone
- § Aux Vases Sandstone
- § St. Louis Limestone
- § Salem Limestone
- § Warsaw Limestone
- § Carper Sandstone

# Compartmentalized Reservoirs



# Illinois Basin Hz Compartmentalized Apps

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## Tested

- § Salem Limestone
- § Devonian Limestone
- § Silurian Limestone

## Untested

Virtually all other limestones in the basin, notably:

- § Renault Limestone
- § Warsaw Limestone
- § Grand Tower Limestone
- § Moccasin Springs Limestone
- § Galena Limestone

# Reservoir Considerations

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## Good Reservoirs make good candidates

- § Permeability
- § Porosity
- § Structure
- § Thickness
- § Oil Column
- § Oil Saturations
- § Oil Viscosity
- § Bottomhole Pressure
- § Drive Mechanism

# Reservoir Considerations

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## Also Consider:

- § **Original Initial Production Rates**
- § **Current Production – Oil and Water**
- § **Cumulative Production**
- § **Original Oil in Place**
- § **Remaining Reserves**
- § **Surface Facilities**
- § **Water Handling Capabilities**



# Benefits & Risks

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## Benefits:

- § **More Reservoir Exposure**
  - § **Less Drawdown**
  - § **More Fractures**
  - § **More Kh**
  - § **More Compartments**
- § **Better Rates**
- § **More Reserves**
- § **Smaller Footprint**
- § **More Flexible Surface Locations**
- § **More More More!!!**

## Risks:

- § **More Expense**
- § **More Geologic Risk**
- § **More Mechanical Risk**
- § **More Well Placement Risk**
- § **More More More!!!**

# Checklist

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## Geologic:

- § Structure Map
- § Thickness Map
- § Net Oil Isopach Map
- § Cross Sections
- § Core / Log Data
  - § Permeability
  - § Porosity
  - § Saturations

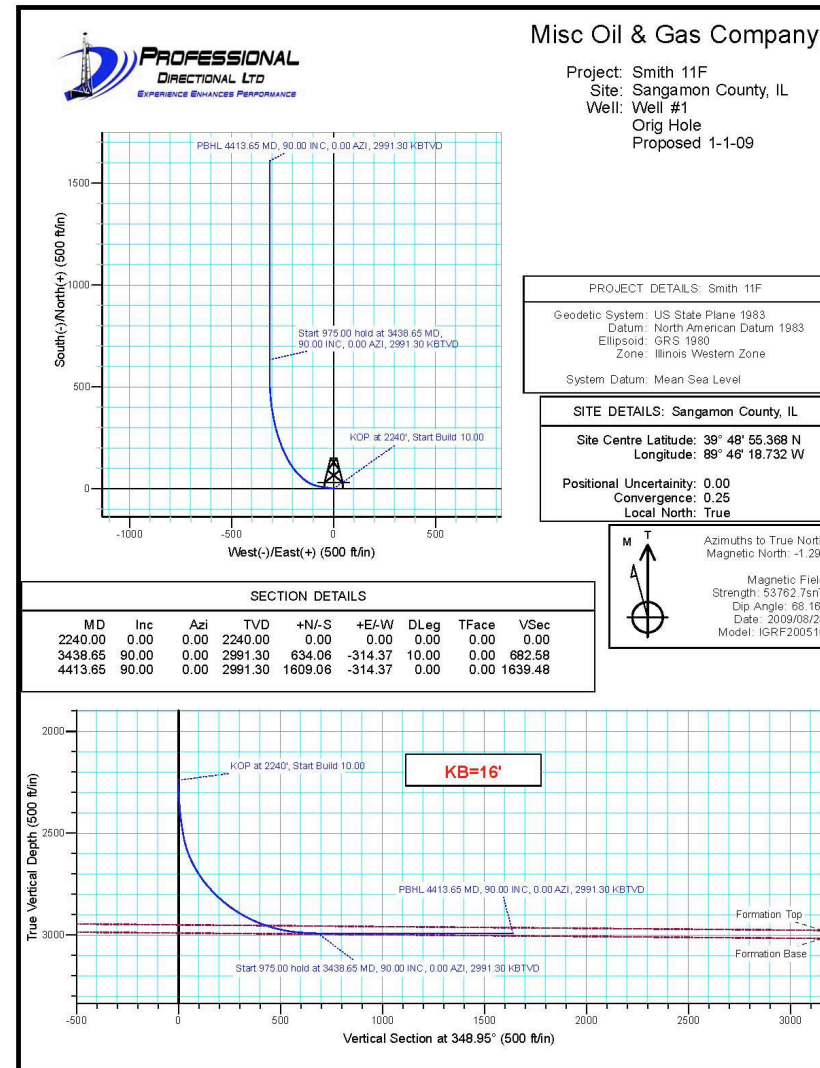
## Engineering:

- § Original Oil in Place
- § Remaining Reserves
- § Drive Mechanism
- § Bottomhole Pressure
- § Cost Analysis
- § Economics

# Drilling – Well Planning



- § Direction
- § Geometry
- § True Vertical Depth
- § Measured Depth / Lateral Length
- § Mud System
- § Geologic Samples / Logging
- § Casing Design
- § Cased vs. Openhole Completion



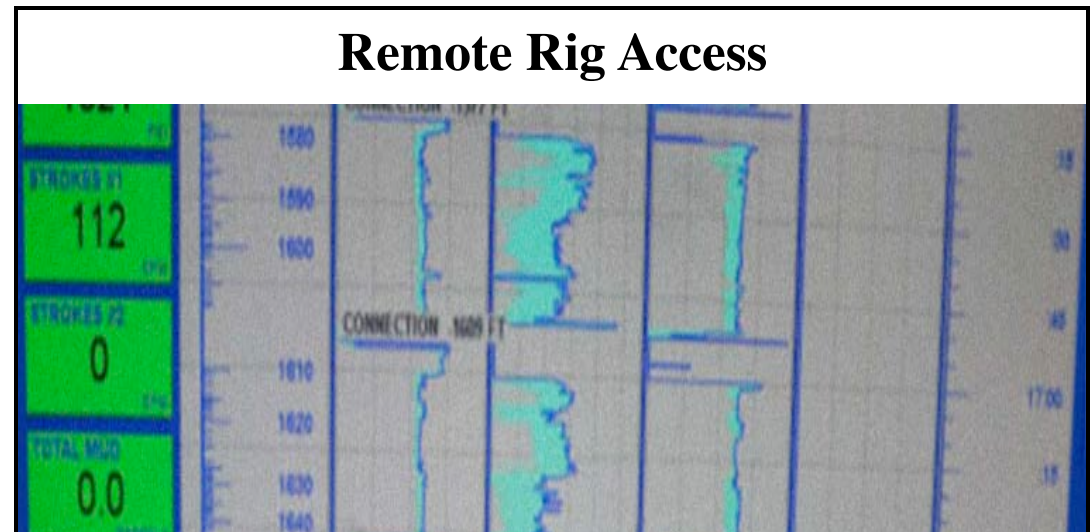
# Drilling - Execution



*“I love it when a good plan comes together”*

- Kenny Goebel, Fall 2006

- § Rig Size, capabilities
- § Mud Pumps
- § Blowout Preventer
- § Drillpipe
- § Mud / Air System
- § Bit Selection
- § Remote Rig Access
- § Directional Drillers
- § Bottomhole Assembly
- § MWD / LWD
- § Casing Design
- § Cementing Program



# Completion Options

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## Openhole:

- § Run casing to top of zone
  - § Drill out with smaller bit
  - § Opportunity to change out mud system if needed
- § Use when no stimulation needed
- § Use for single stage stimulation
- § May need some mud cleanup work
- § Lightly swab or pump in coning application
- § It is possible to run packer system at a later date to isolate or stimulate

## Cased Hole:

- § Run casing to top of zone
- § Drill out to TD
- § Run in casing
  - § Cement and perforate
  - § Use Packer system
- § Multistage Frac is possible
- § Can isolate with bridgeplugs or cement squeeze

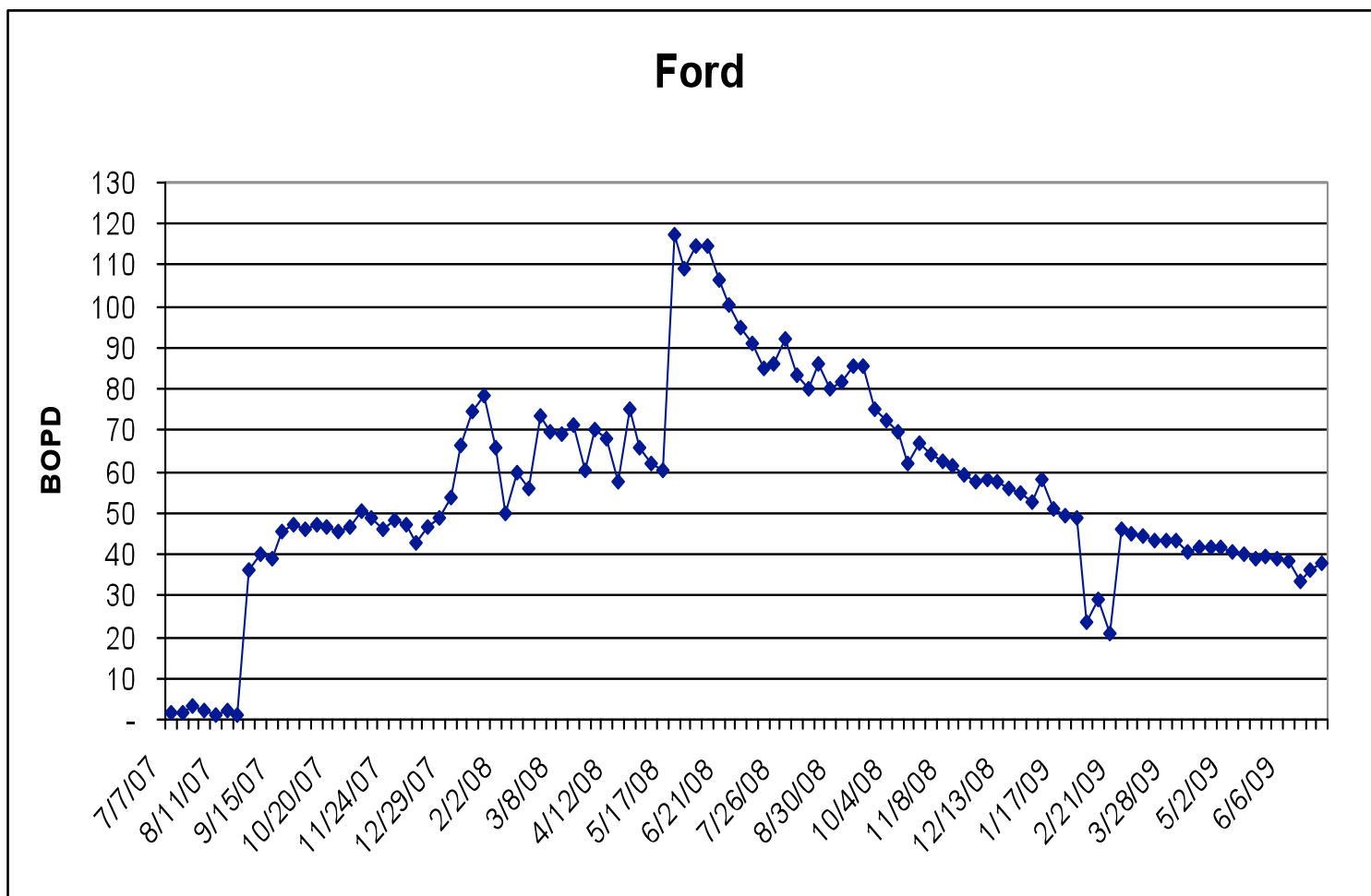
# Production Practices

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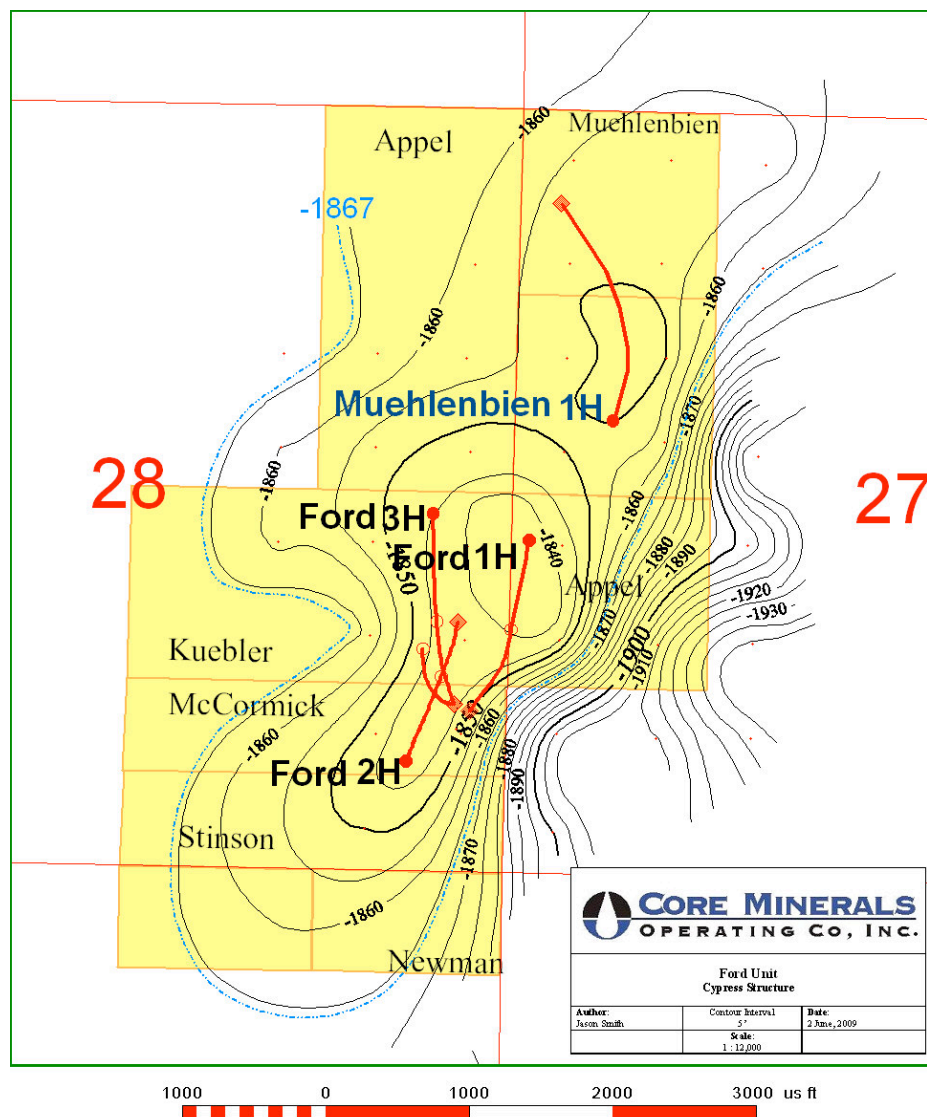


- § **Determine depth to set pump**
  - § **For Coning App – Set pump shallow to reduce drawdown**
  - § **For other Apps – set pump around the curve to maximize rate**
    - § **Use rod design program to account for extra drag**
- § **Monitor annular fluid levels to optimize pumping rate**
- § **Use submersible pump for high rate wells**
  
- § **Design Surface facilities to handle expected fluid**
- § **May need free water knockout to handle high rate wells**
- § **Water disposal capabilities may need to be upgraded**

# Results – One Project – Ford Lease



# Ford Unit



As of May 1<sup>st</sup> of 2010 the Ford Unit had produced **51,000** bbls from three horizontal wells; 2 drilled in 2007 and 1 drilled in 2008. The three wells are still producing 25 GBOPD. At least two additional locations remain in the Field.

## **Acknowledgements**

**Jeff Hoy – Noble Energy, Inc.**

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