

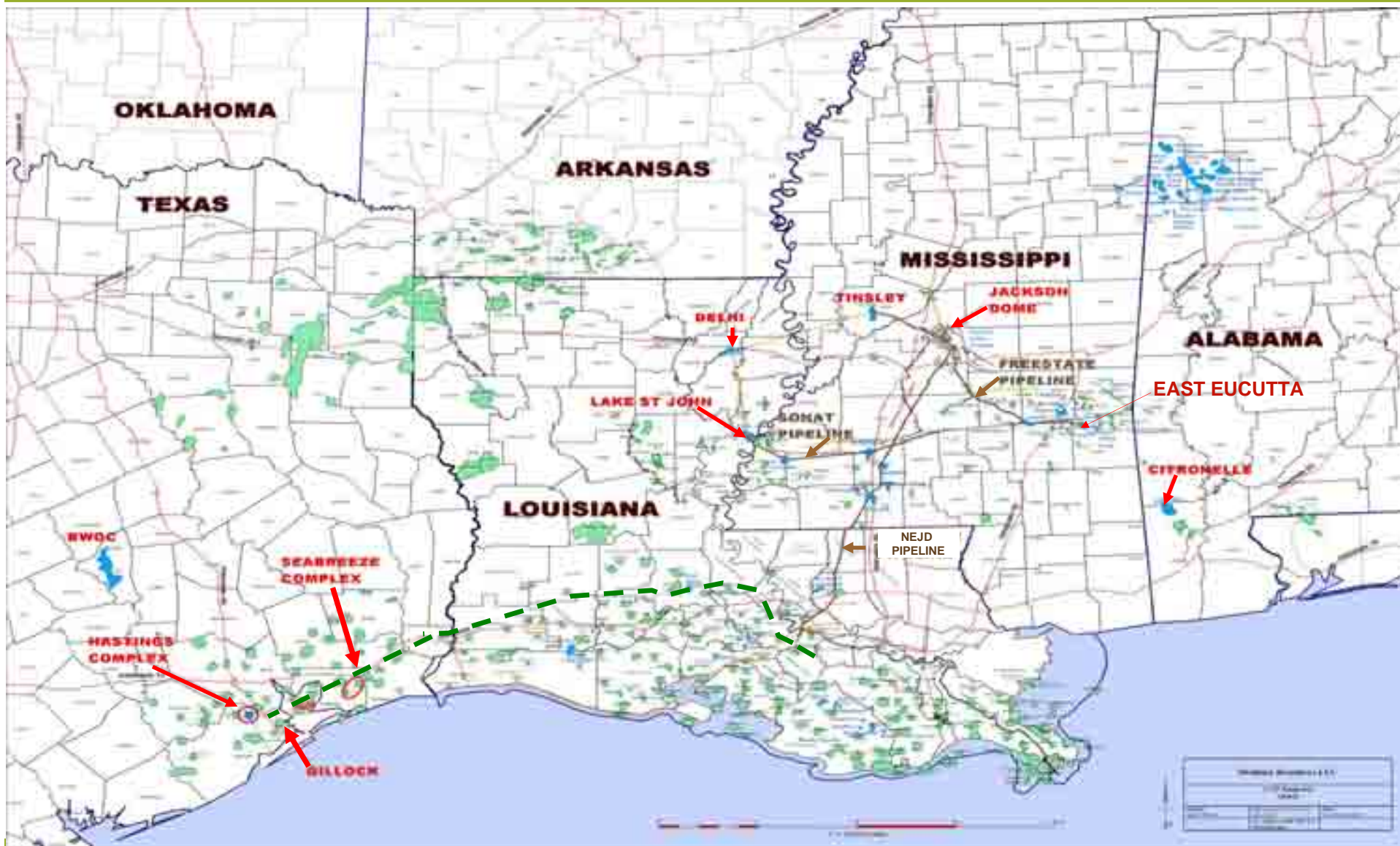


# CO<sub>2</sub> EOR With Carbon Sequestration Form

Reservoir Management of a CO<sub>2</sub> Flood

Denbury Resources Inc.

# Key Operating Areas



# Company Snapshot

- ✚ Denbury is the largest oil and gas producer in the State of Mississippi
- ✚ Primarily as a result of CO<sub>2</sub> enhanced oil recovery and Denbury's efforts, Mississippi's oil production has reversed its decline and is actually increasing
- ✚ Denbury currently operates nine (9) active CO<sub>2</sub> enhanced oil recovery projects in Mississippi and is in the process of initiating three (3) new floods during 2008
- ✚ Denbury currently injects approximately 500 MMcf (+/- 30,000 tons) of CO<sub>2</sub> per day into the nine active floods
- ✚ Based on our injection volumes we believe we are the largest injector of CO<sub>2</sub> on a daily basis in the U.S.
- ✚ Denbury currently operates approximately 320 miles of CO<sub>2</sub> pipelines and is in the process of constructing an additional +/- 400 miles of CO<sub>2</sub> pipelines.
- ✚ Since 1999, Denbury has produced in excess of 20 MMBbls of oil from CO<sub>2</sub> Flooding

# Reservoir Management of a CO<sub>2</sub> Flood

## Geological Description

- Tank must be described
  - Size
  - Boundaries
  - Continuity
  - Reservoir characteristics

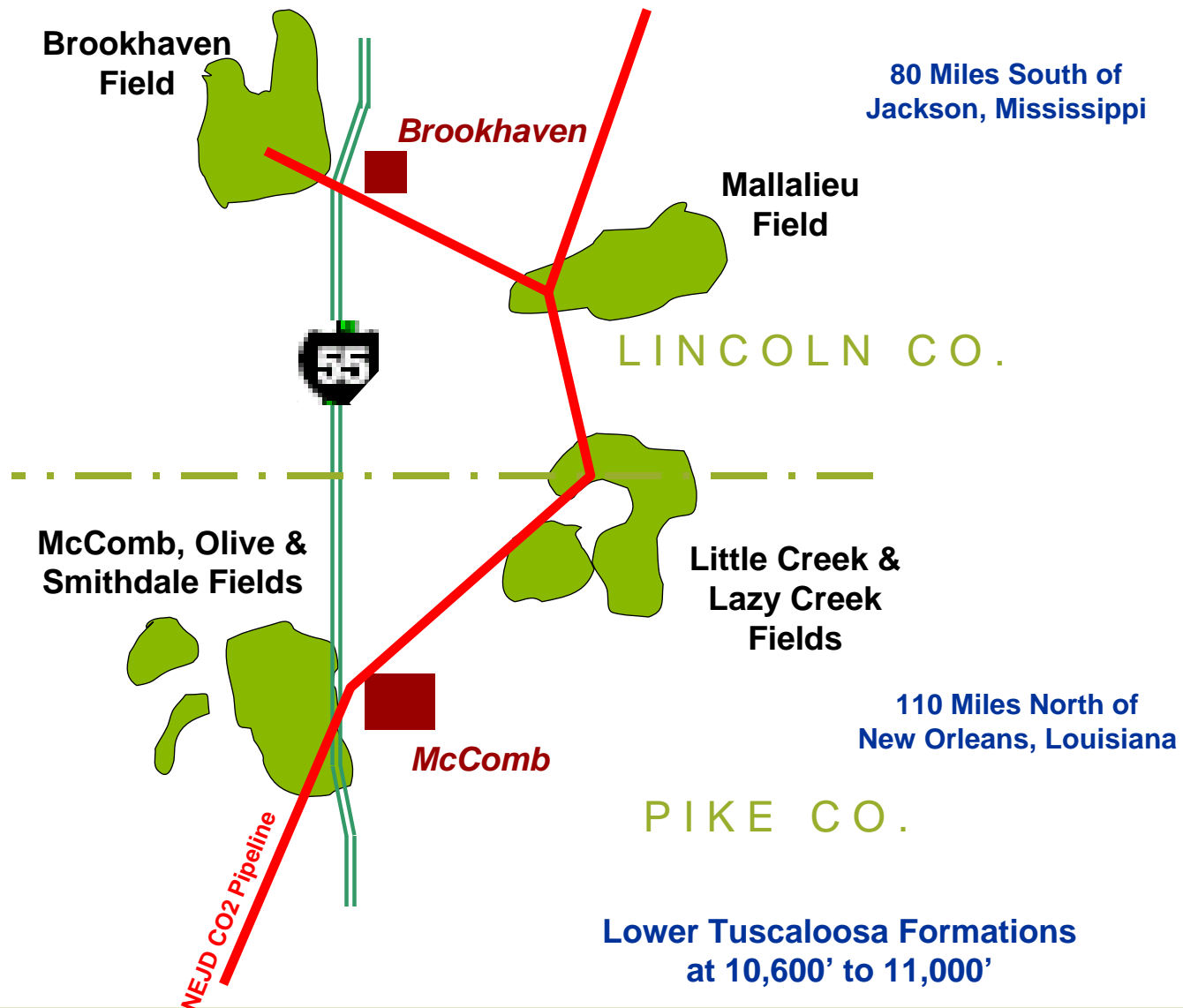
## Reservoir Characterization

- Detail reservoir analysis
  - PVT / CO<sub>2</sub> swelling
  - Special core analysis
  - Simulation

## CO<sub>2</sub> Management

- Every CO<sub>2</sub> molecule is important
  - Contact oil
  - Control and contain

# Map of Lincoln and Pike Counties





# General Data

	<u>Little Creek</u>	<u>West Mallalieu</u>
Discovery Date	January, 1958	1946
Unitization Date	March, 1962	April 30, 1982
Producing Formation	Lower Tuscaloosa	Lower Tuscaloosa
Primary Producing Mechanism	fluid expansion	fluid expansion/weak water drive
Nominal Well Spacing (acres/well)	40	40
Average Depth (FT)	10,750'	10,550'

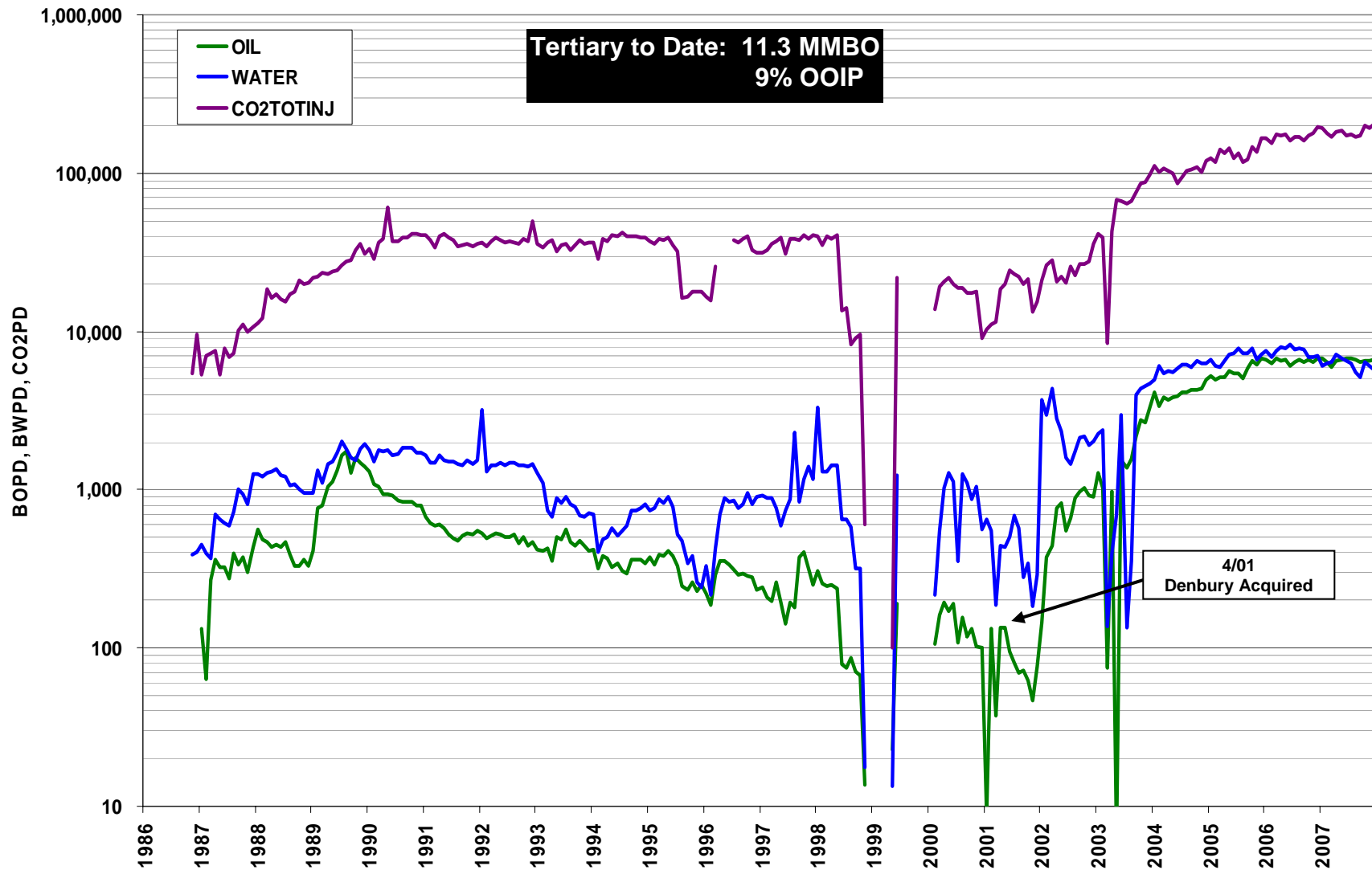
## Reservoir Data

Original Oil-In-Place (MMSTB)	123	122.2
Area (acres)	7,522	3,574
Porosity (%)	23.4	25.9
Water Saturation (%)	59	52.8
Permeability (md)	90	54.5
Oil Gravity (°API)	40	40
Oil FVF (RB/STB)	1.32	1.26
Gas Oil Ratio (SCF/STB)	555	425
Original Pressure (psig)	4,850	4,700
Reservoir Temp (°F)	248	245

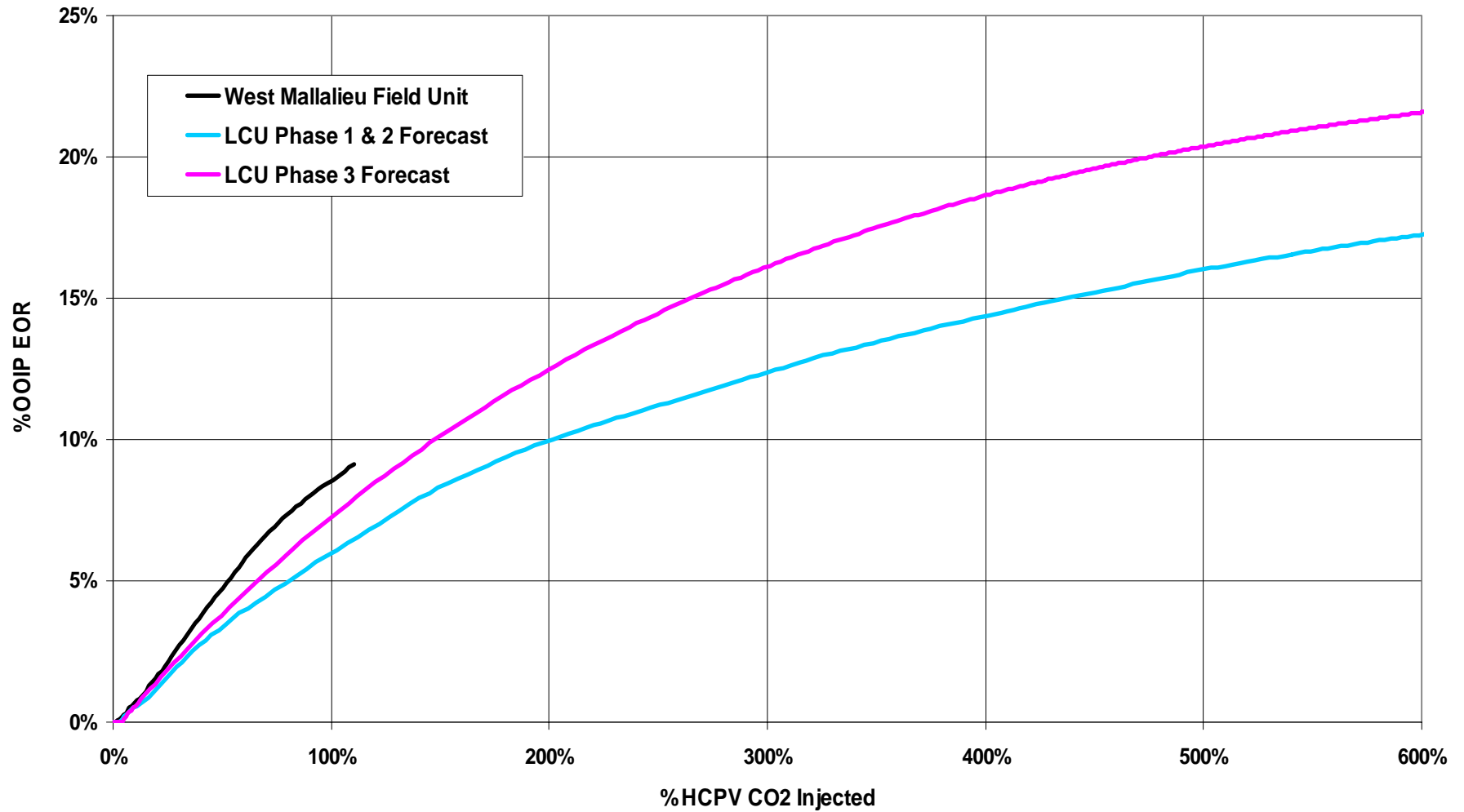
## Production Data

Number of Producing Wells	36	44
Number of CO2 Injectors	35	32
Cumulative Oil Production (MMSTB)	63.8	38.4
(% OOIP)	51.9%	31.4%
Current Oil Rate (BOPD)	2,600	6,500

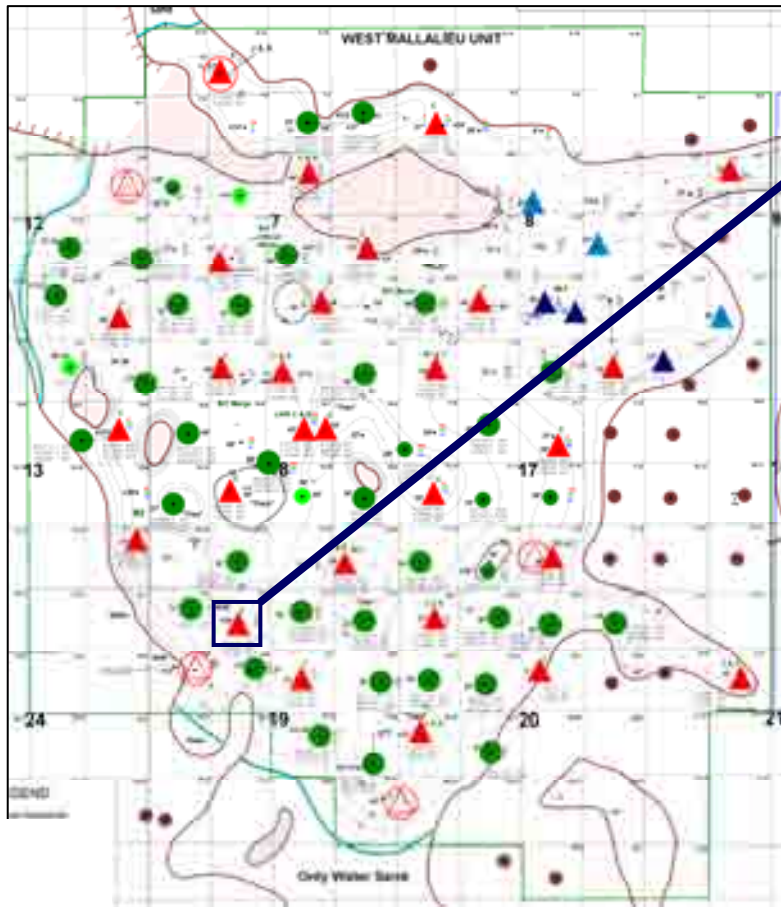
# West Mallalieu Field



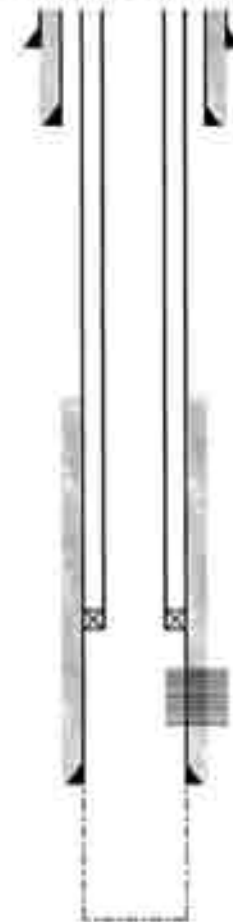
# Little Creek vs West Mallalieu Field



# WMU 19-3 Inj Wellbore



CURRENT WELLBORE DIAGRAM



**KB: 395'**  
**Spud: 8/1948**

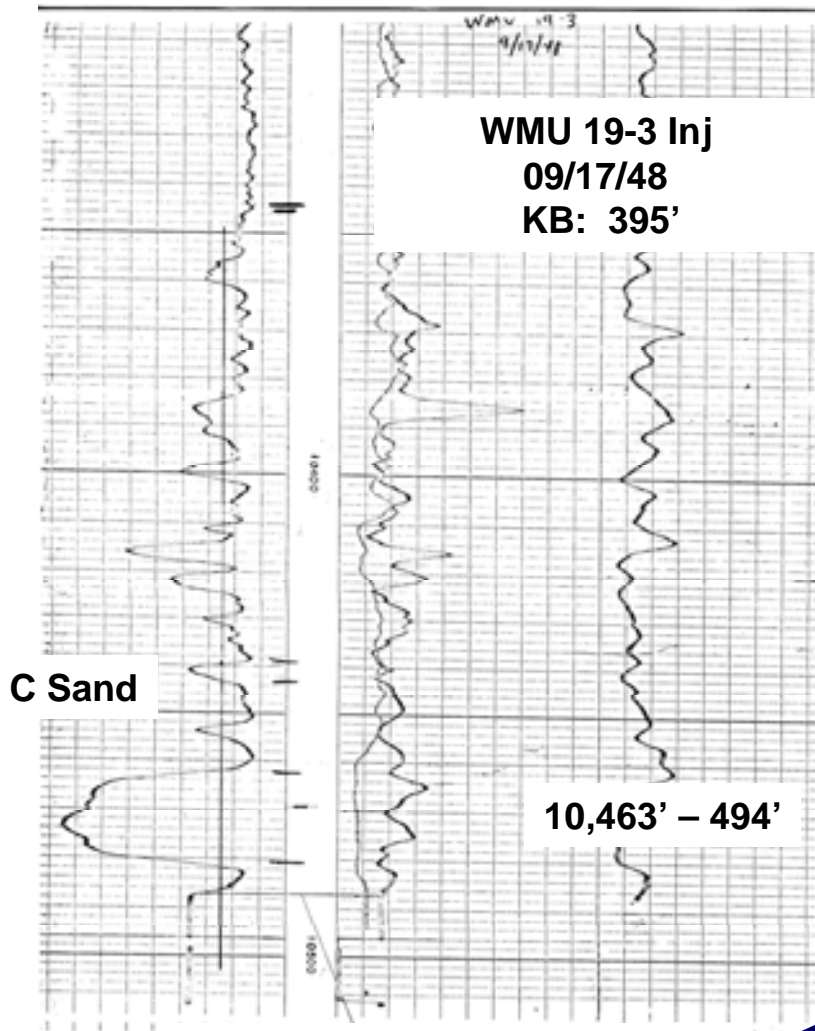
**Conductor**  
**9-5/8" @ 1,948'**

**2-3/8" Tubing**  
**SS SN**  
**Packer @ ~10,380'**

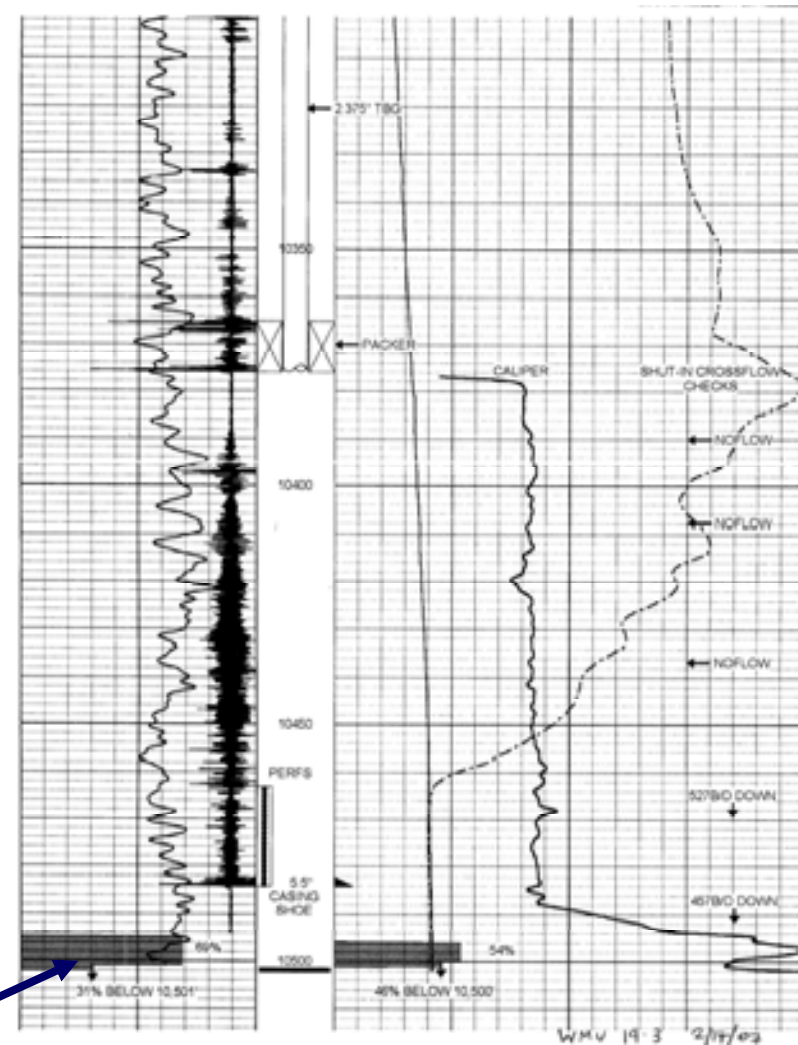
**Lower Tuscaloosa**  
**C Sand**  
**10,463' – 10,494' (31')**

**5-1/2" @ 10,484'**  
**146' of Open Hole to 10,530'**

# WMU 19-3 Inj Logs



Profile indicates all CO<sub>2</sub> going below interval into open hole

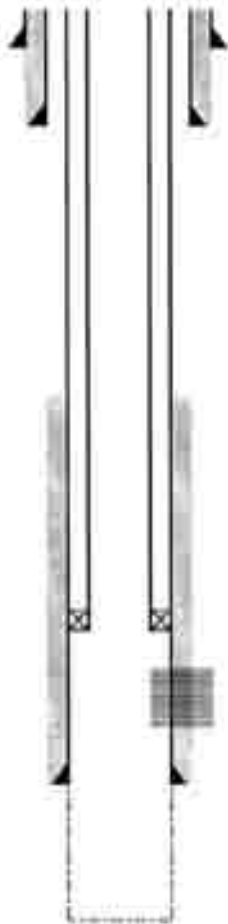


WMU 19-3 Inj  
02/14/07

# WMU 19-3 Inj Wellbores

KB: 395'  
Spud: 8/1948

CURRENT WELLBORE DIAGRAM



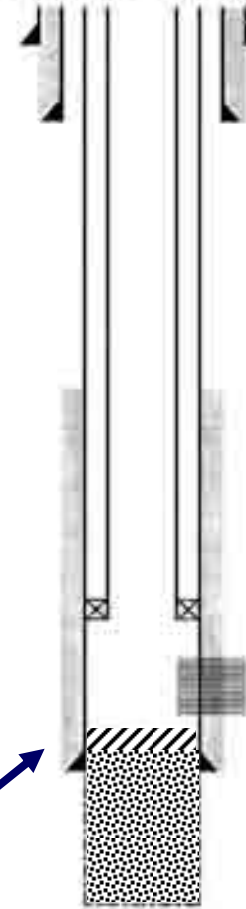
Conductor  
9-5/8" @ 1,948'

2-3/8" Tubing  
SS SN  
Packer @ ~10,380'

Lower Tuscaloosa  
C Sand  
10,463' – 10,494' (31')

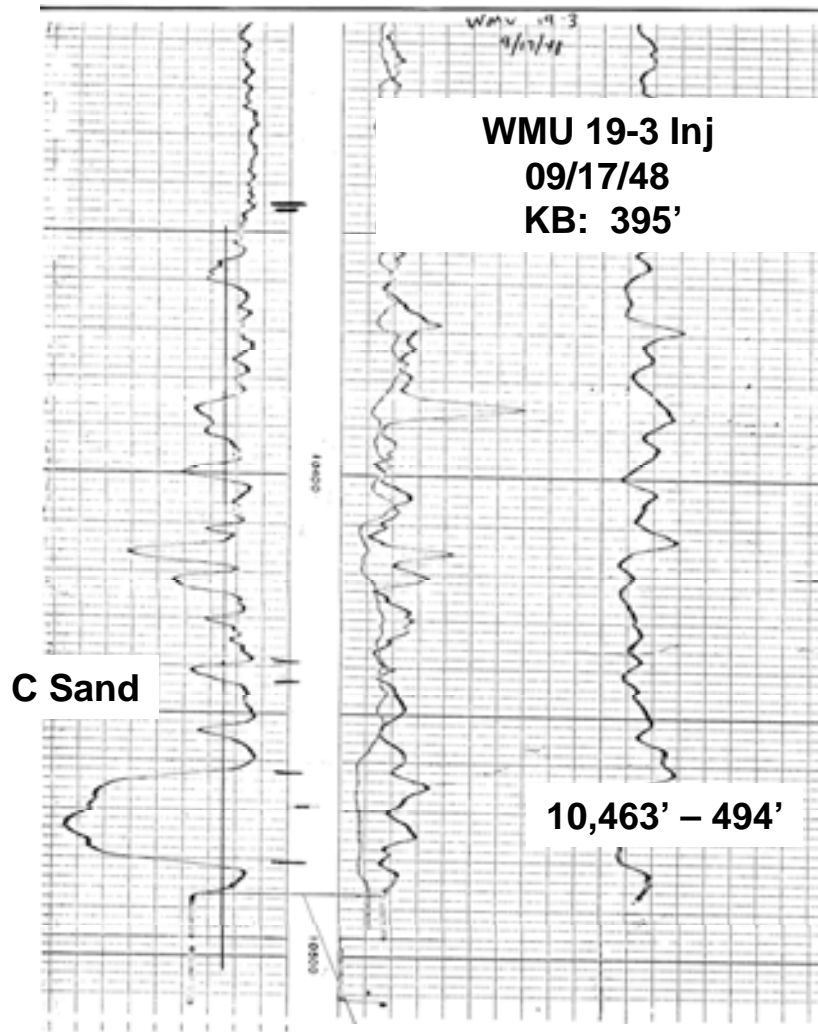
5-1/2" @ 10,484'  
Open Hole to 10,530'

CURRENT WELLBORE DIAGRAM

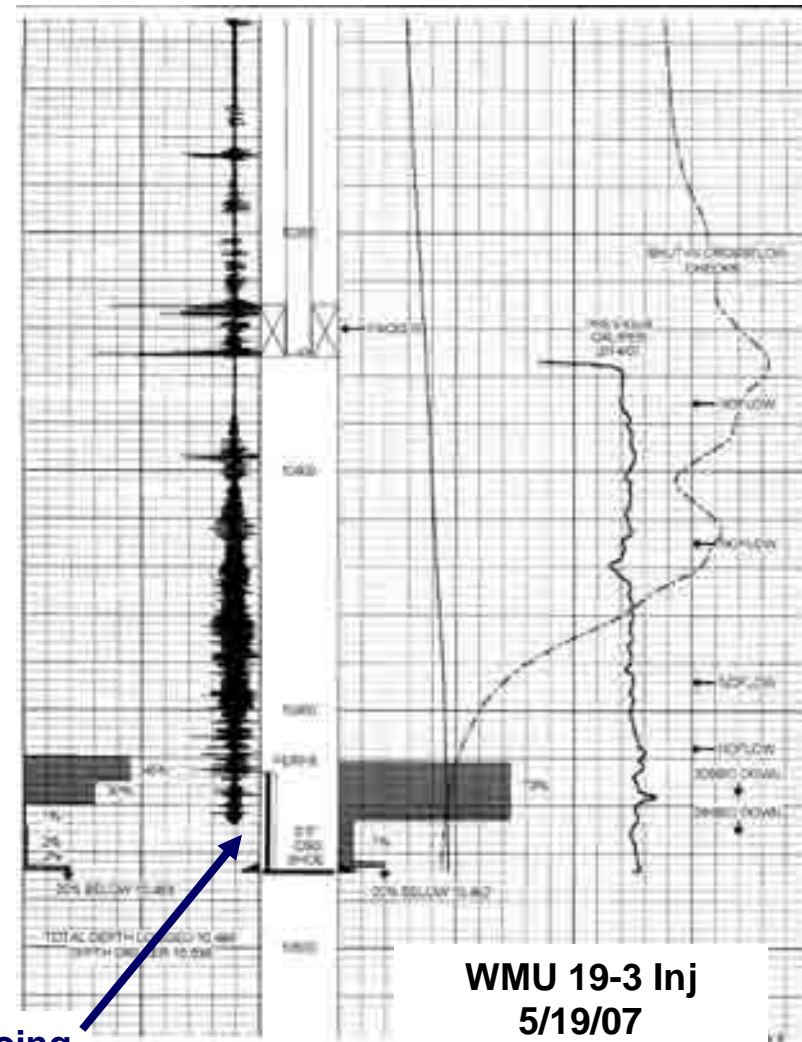


Spotted sand (4X) checking with slick line  
Once satisfied, capped with 6' cement.

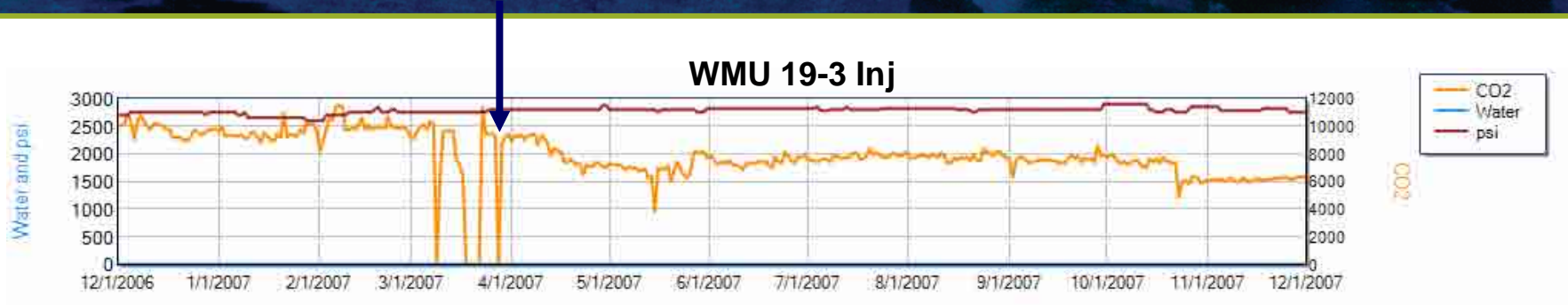
# WMU 19-3 Inj Logs 2



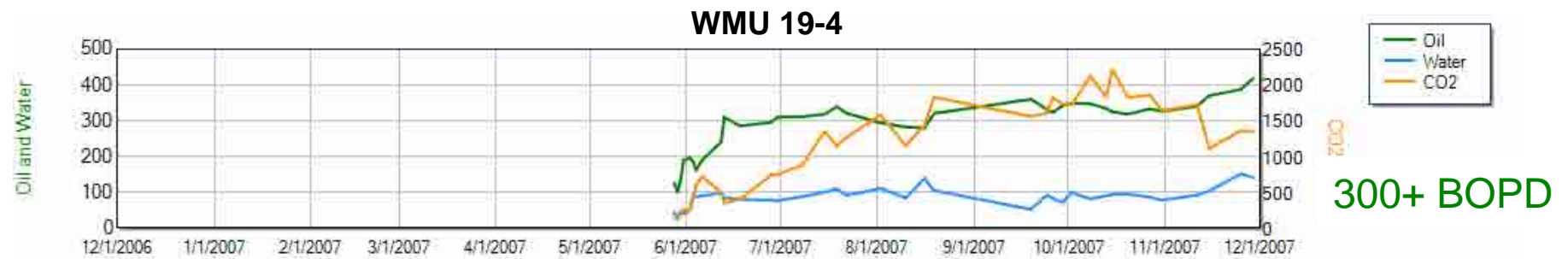
Second profile indicates CO<sub>2</sub> going into C Sand



# WMU 19-3 Inj Results

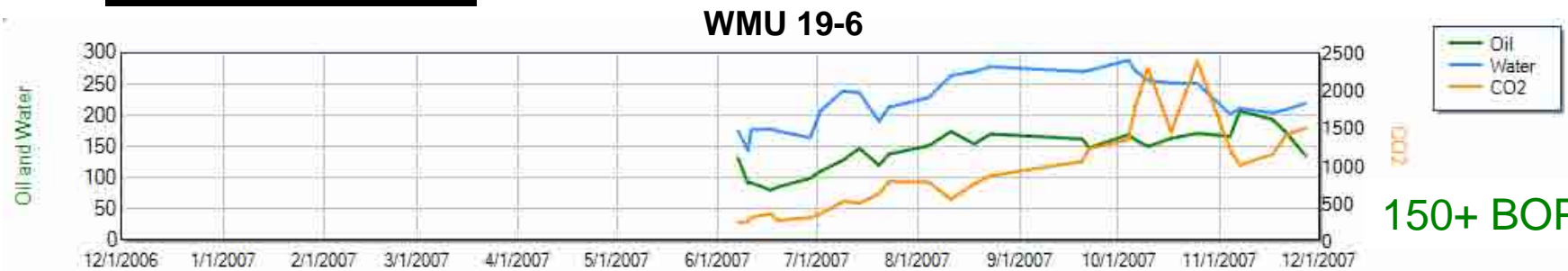


**By setting the sand/cement plug, CO<sub>2</sub> was forced into zone of interest**



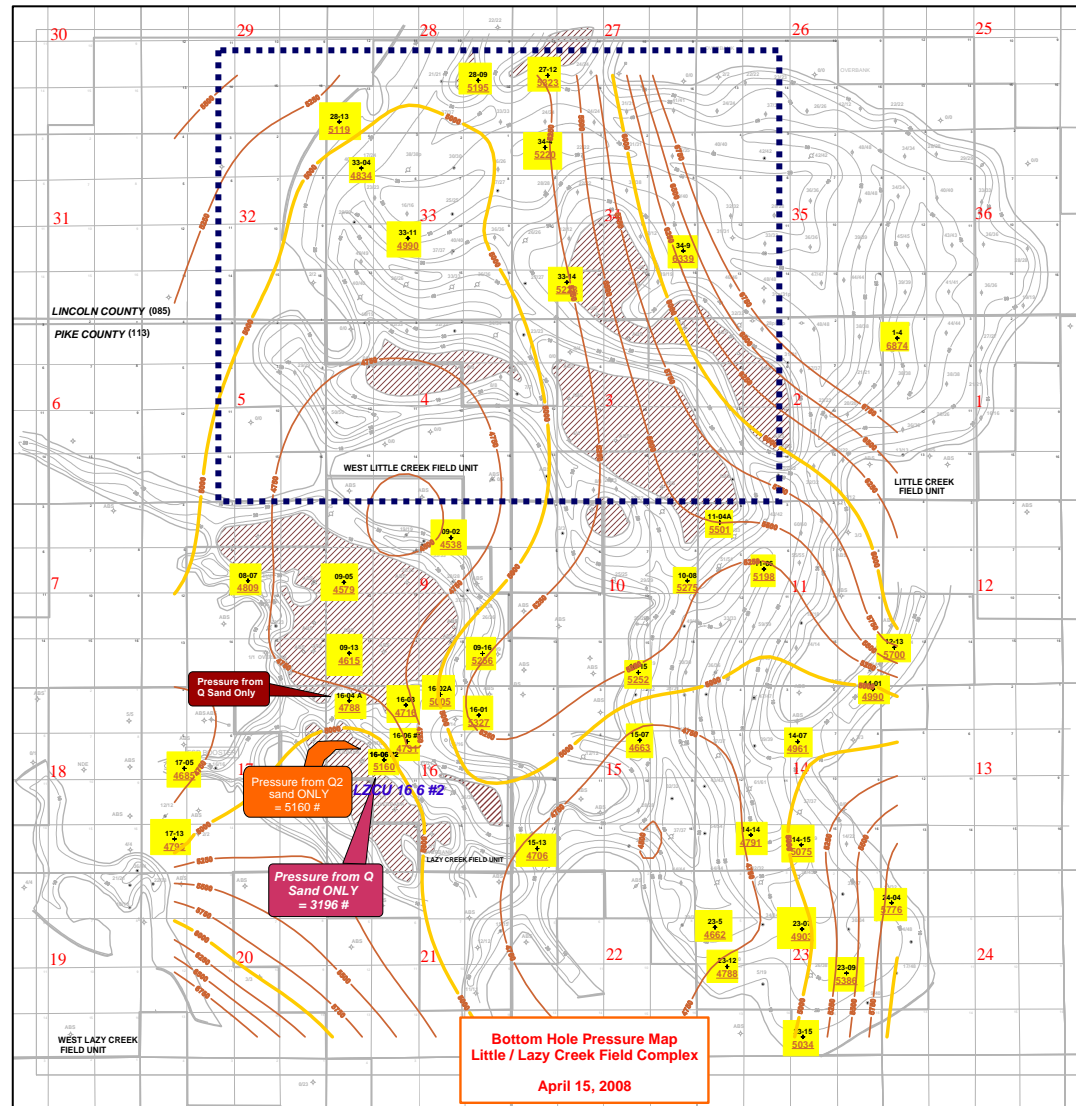
**300+ BOPD**

**Offsetting wells respond**

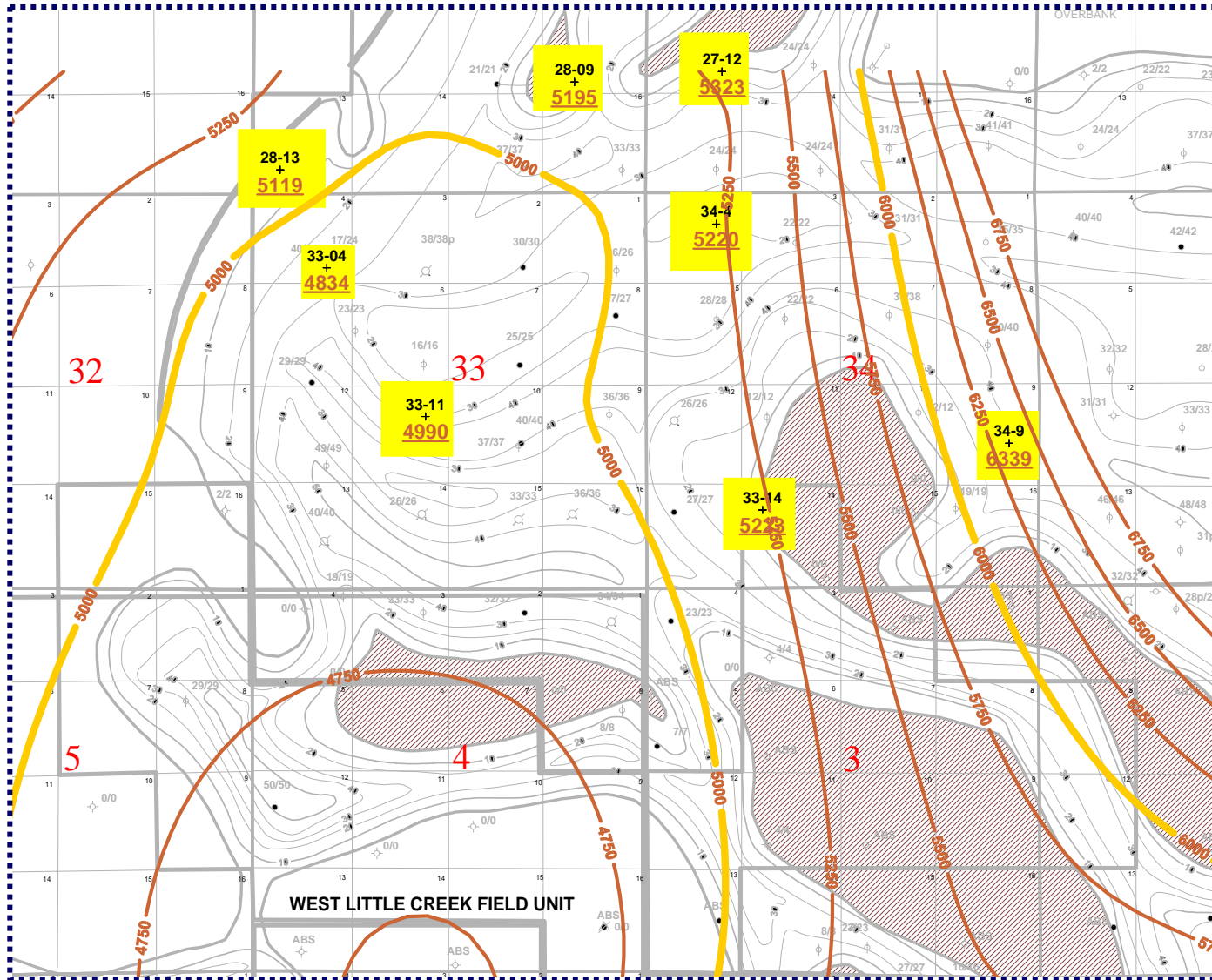


**150+ BOPD**

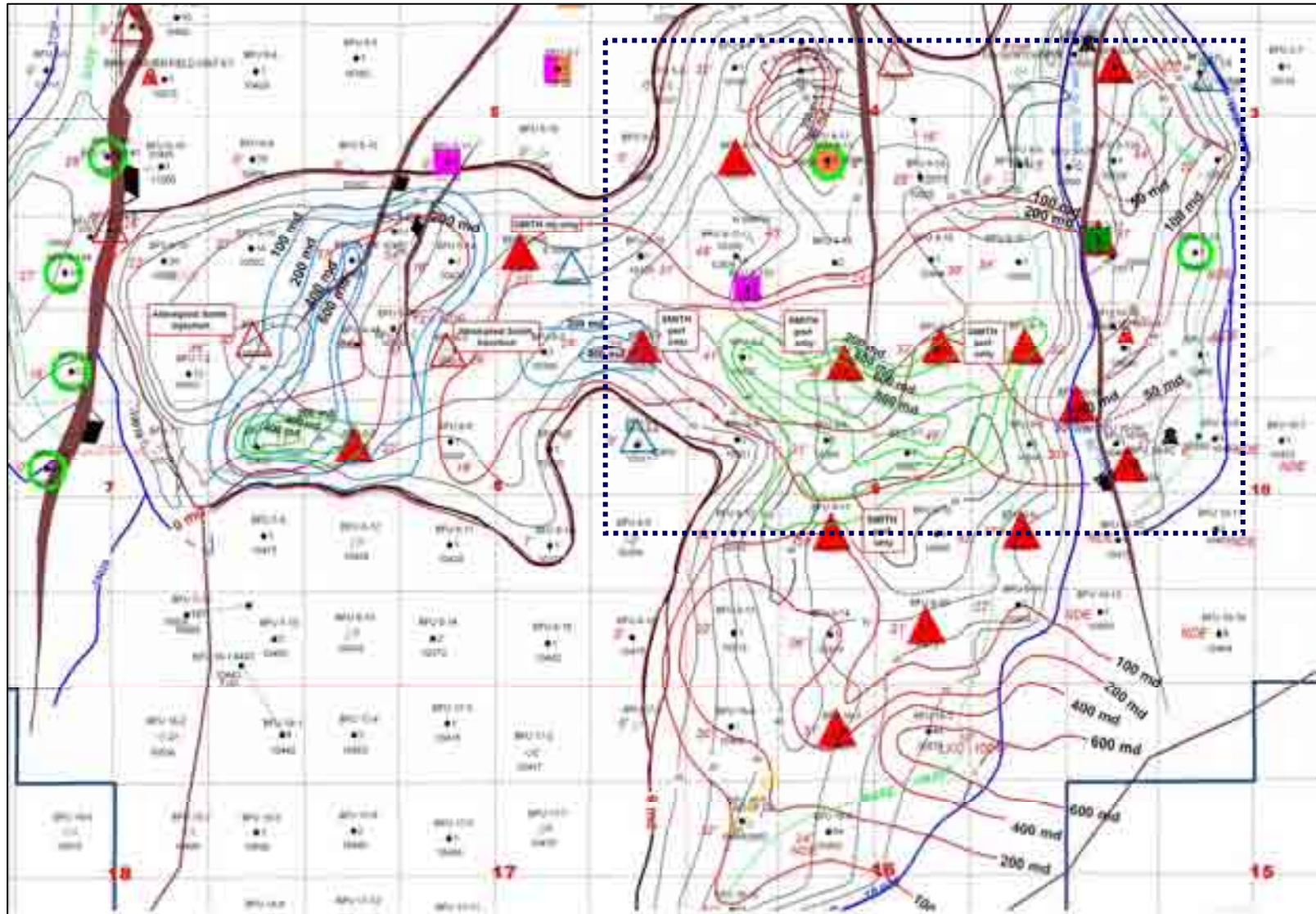
# Little Creek Field



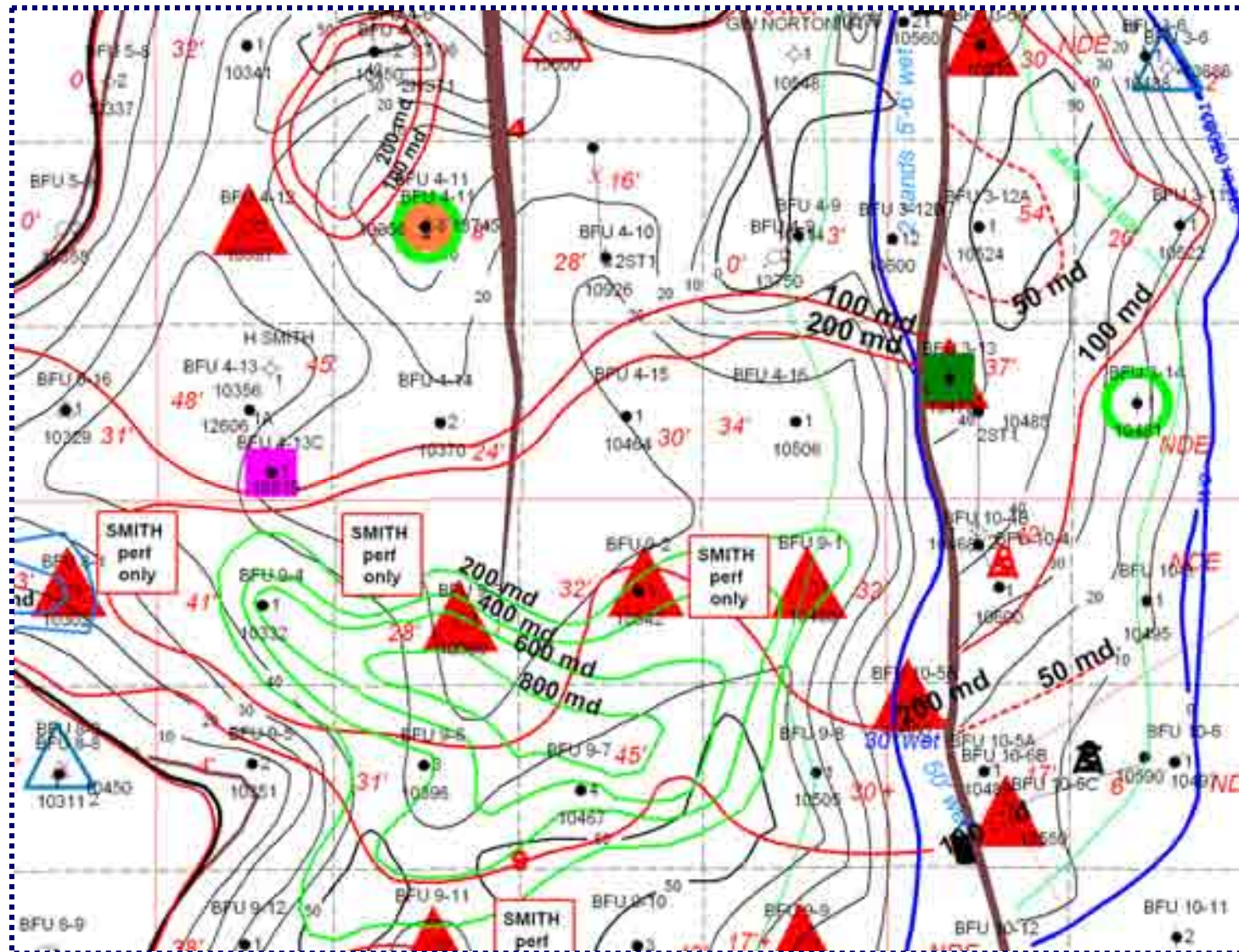
# Little Creek Field



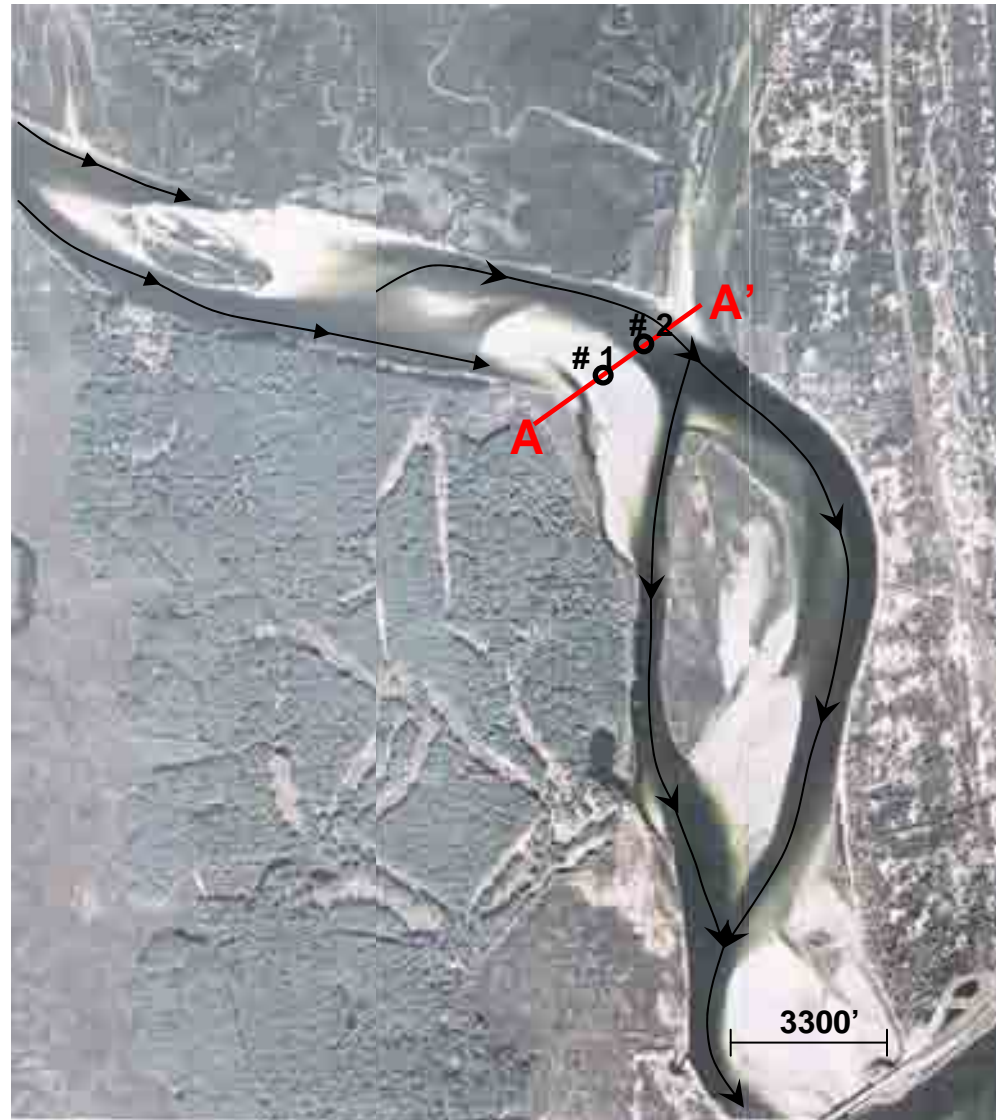
# Brookhaven Field – Smith Perm Map

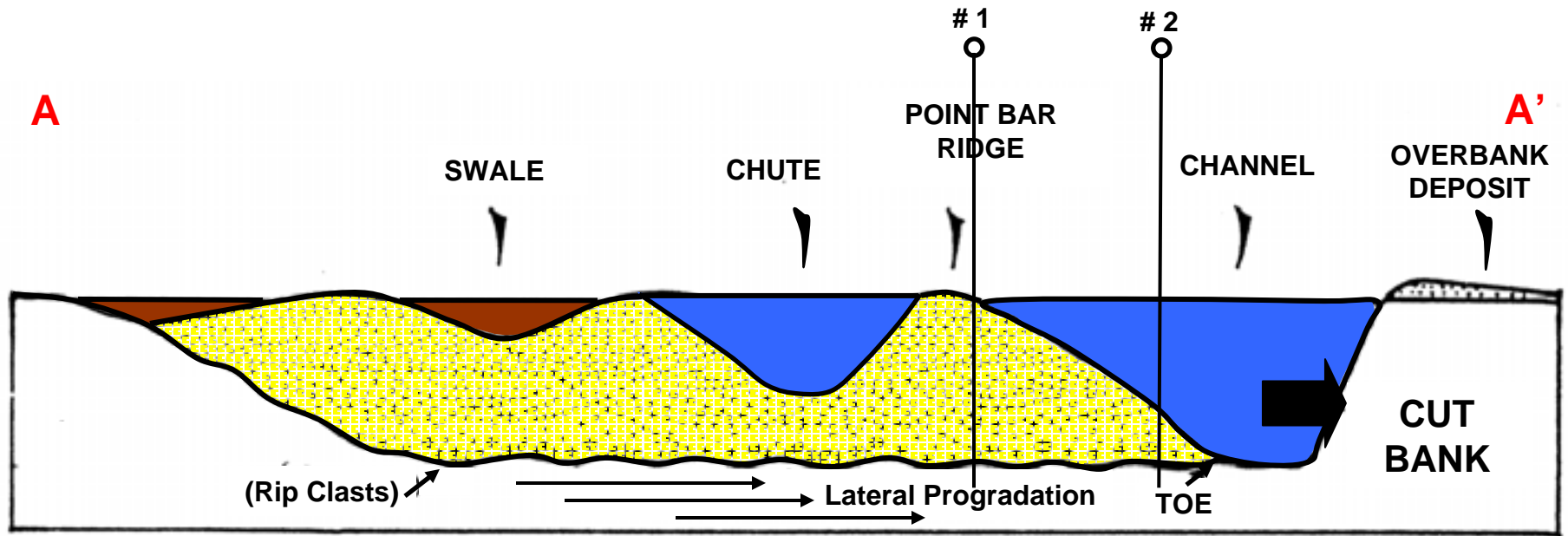


# Brookhaven Field – Smith Perm Map



When debating the potential value of shooting 3D seismic over an established oil field drilled on 40 acre spacing a view of present day fluvial deposition is a great place to start. This meandering sequence dramatically depicts the abrupt variability of clastic deposition (avulsion) in orientation, thickness and connectivity. Depositional features like chutes, overbank deposits, anastomosing channels and opposing bars that typically are common to fluvial deposition can be seen. Not so apparent are the swales, point bar toe (lag) deposits and eddy currents.





## MEANDER BELT

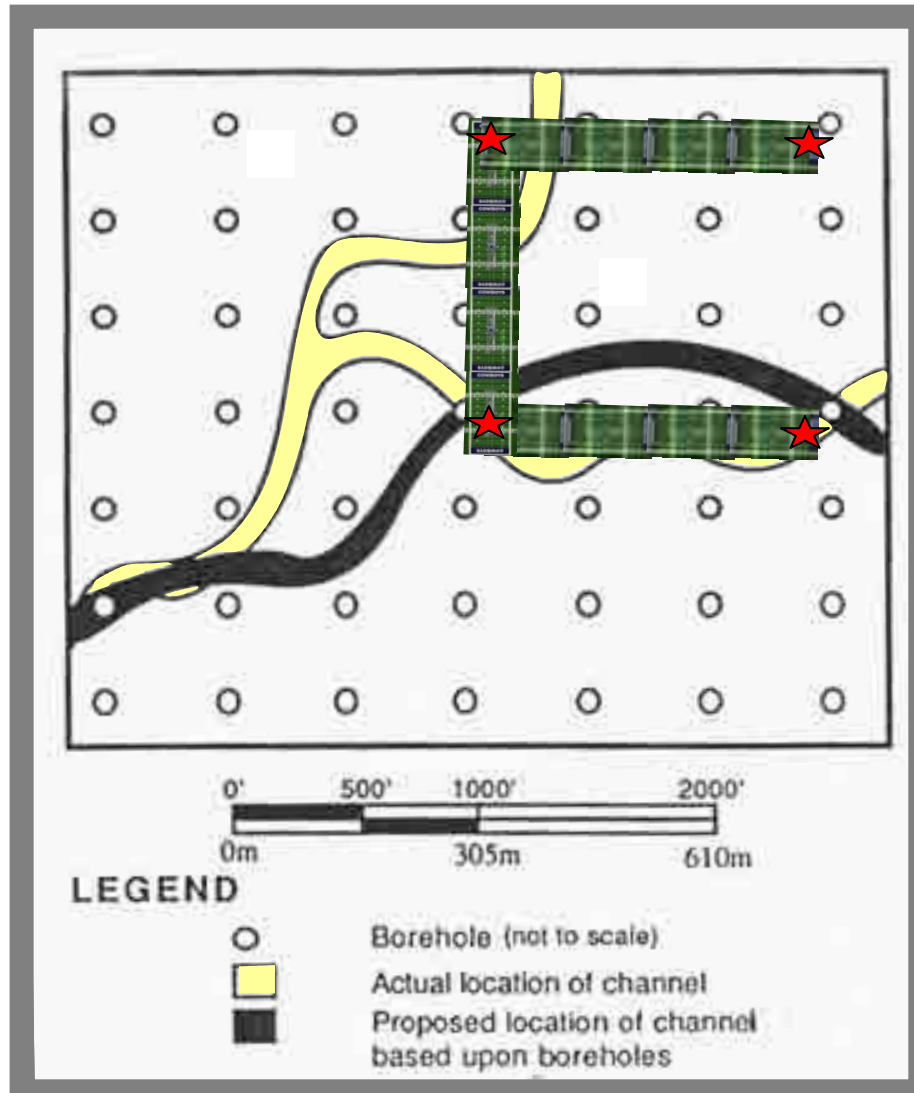
In cross-section view the lateral prograding point bar sequence depicts (from left to right) the trailing bar edge and erosional surface, initial swales (scour holes formed by eddy currents during minor flood stages), early ridge lines formed by winnowing of sand from the adjacent swales (scour holes), main chute (formed and usually only active during a major flood stage), the active ridge, toe, main channel, cut bank and overbank deposit (time equivalent but not connected to the point bar complex).

220 Acres

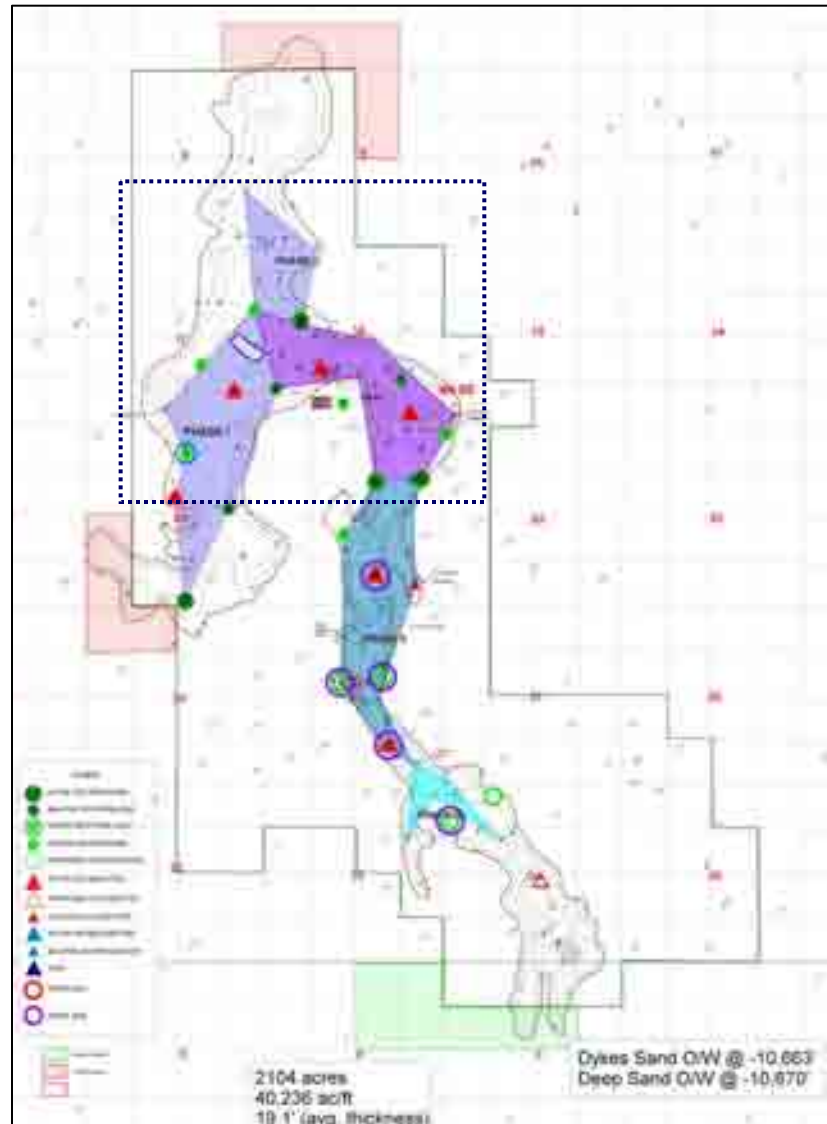
49 Wells

4.5 Acre Spacing

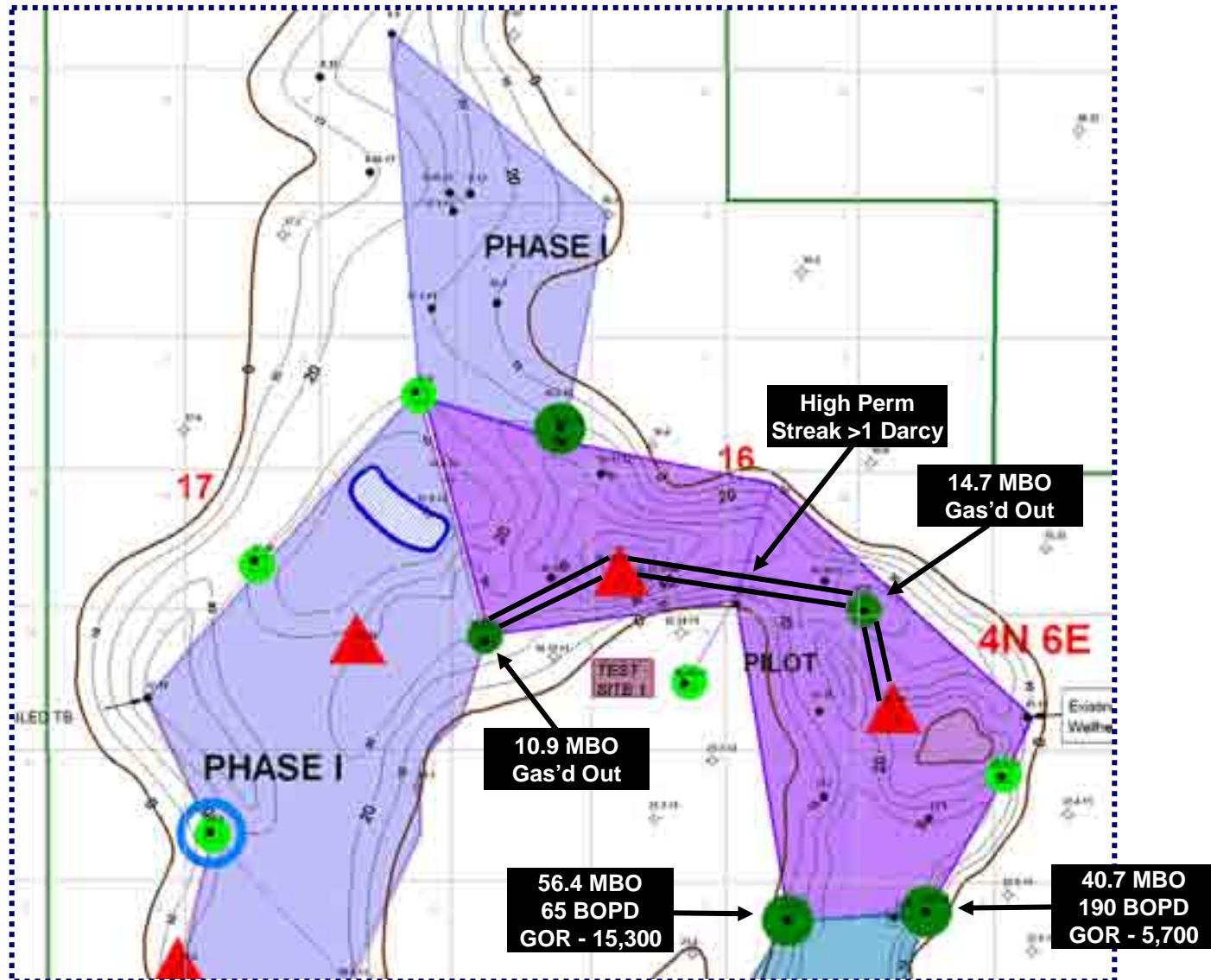
Wells drilled on 40 acre spacing are 1320' apart (about four football fields between wells...think of each well as a goal post).



# Smithdale Field



# Smithdale Field

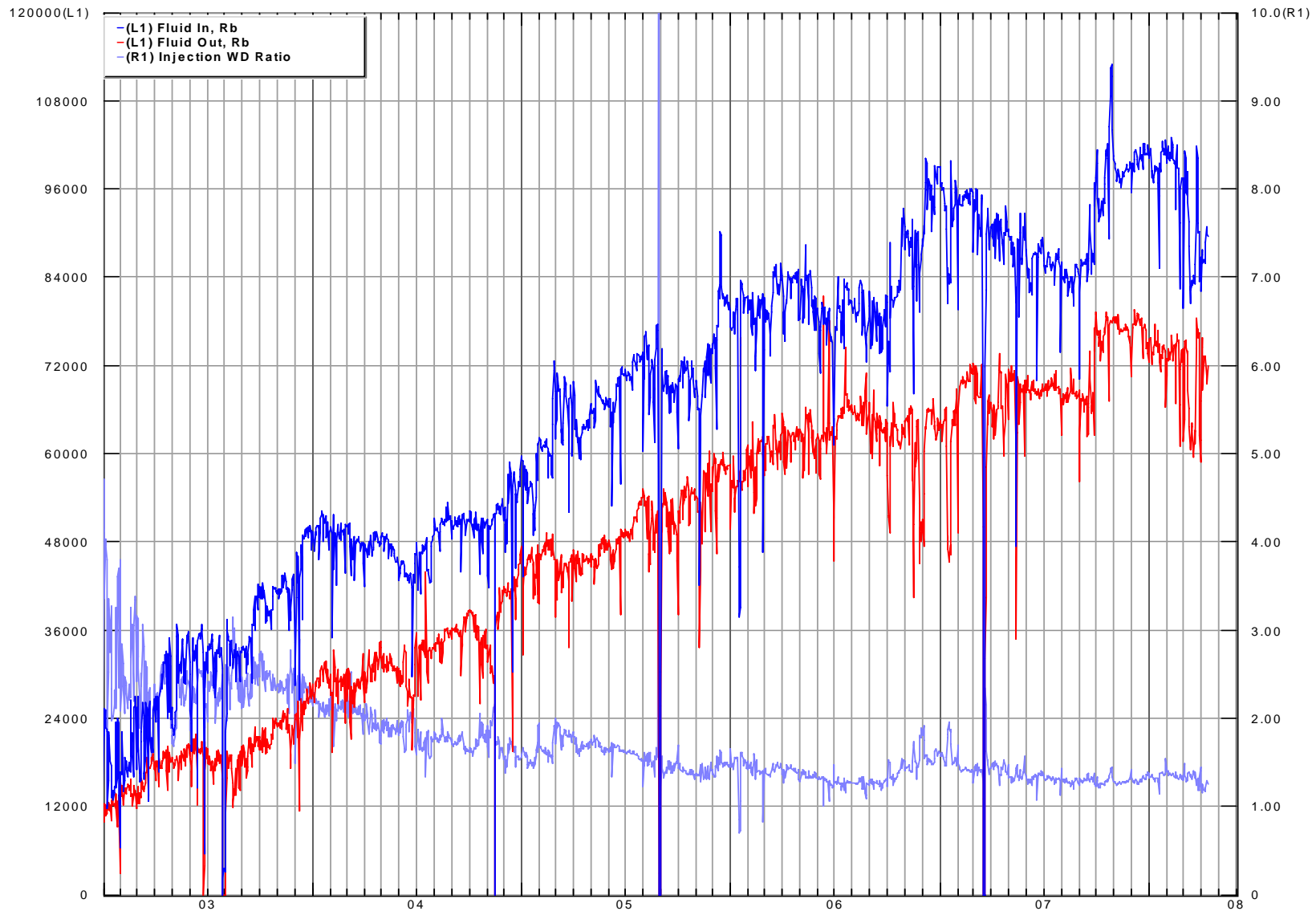


# Why Seismic?

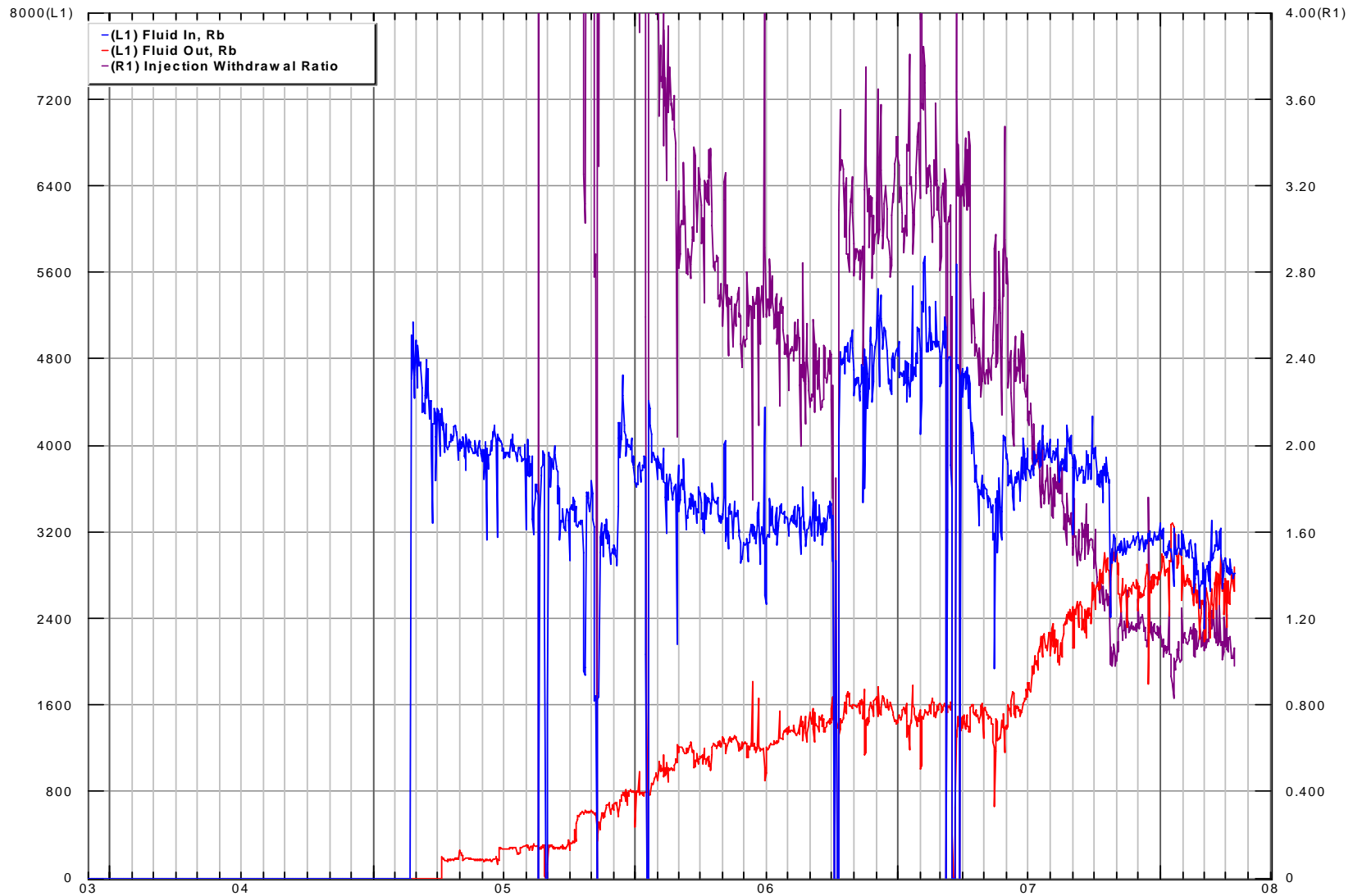
- ✦ **Where are the channels?**
  - 25 feet can mean a dry hole or an oil well
- ✦ **How do the channels connect?**
  - Multiple channels going multiple directions
- ✦ **What was the direction of deposition?**
  - Preferred flow direction of injected and produced fluids
- ✦ **Where is the edge of the reservoir?**
- ✦ **All of the above help us plan our CO<sub>2</sub> flood more efficiently**

***Future – Time Lapsed Seismic***

# West Mallalieu Field



# West Mallalieu Field – Phase 4 Pattern 19-03



# Reservoir CO<sub>2</sub> Management



## Conformance

- Injection Profile
- Pressure – Data / Isobaric Maps



## Permeability Variances

- Mapping of core data
- Pressure transient analysis



## Pattern Balancing

- IWR 1.2 - 1.4