



# ***Optimizing Granite Wash Horizontal Drilling***

AUSTRALIA

ARGENTINA/CHILE

CANADA

EGYPT

NORTH SEA

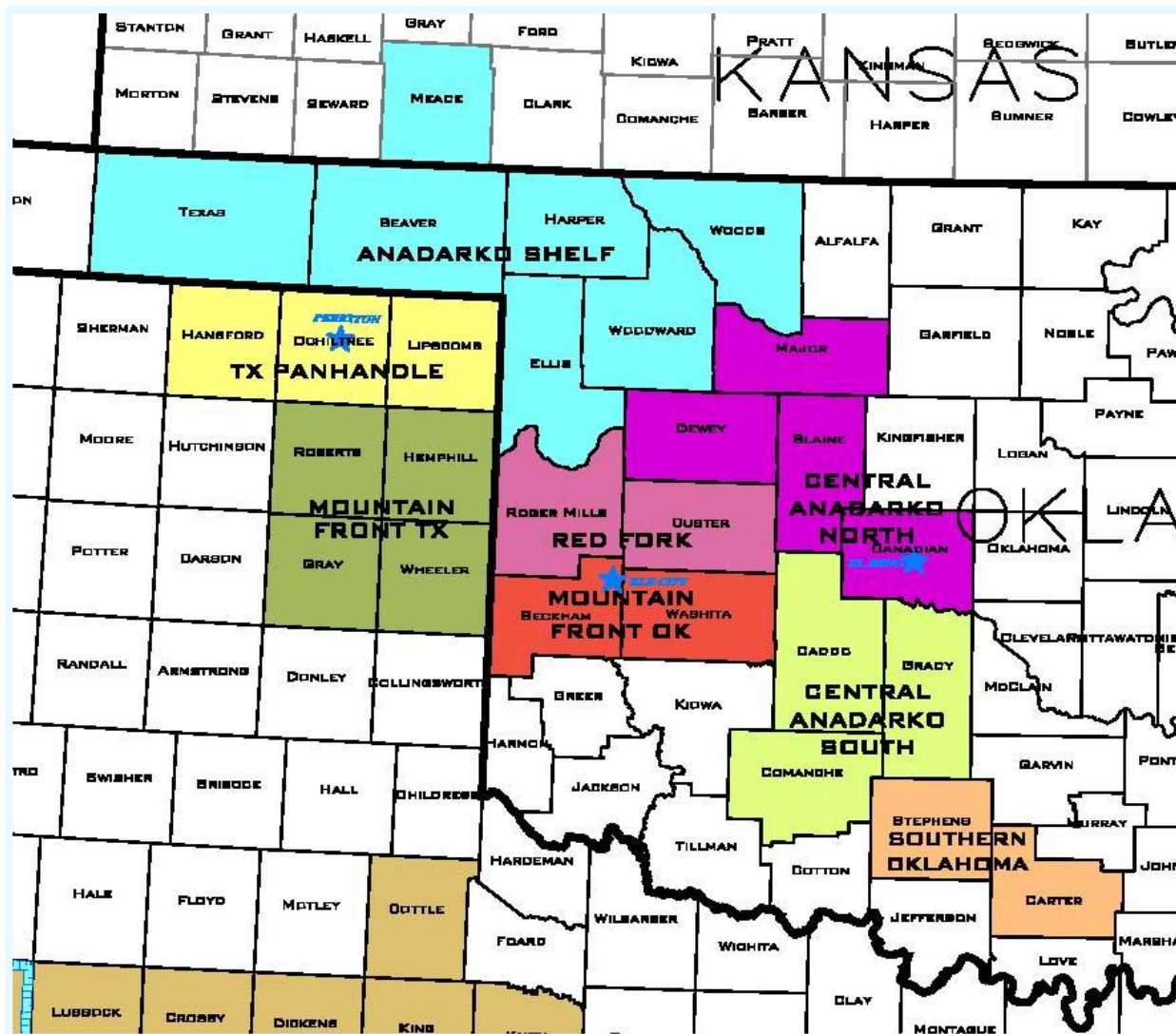
U.S. CENTRAL

U.S. GULF

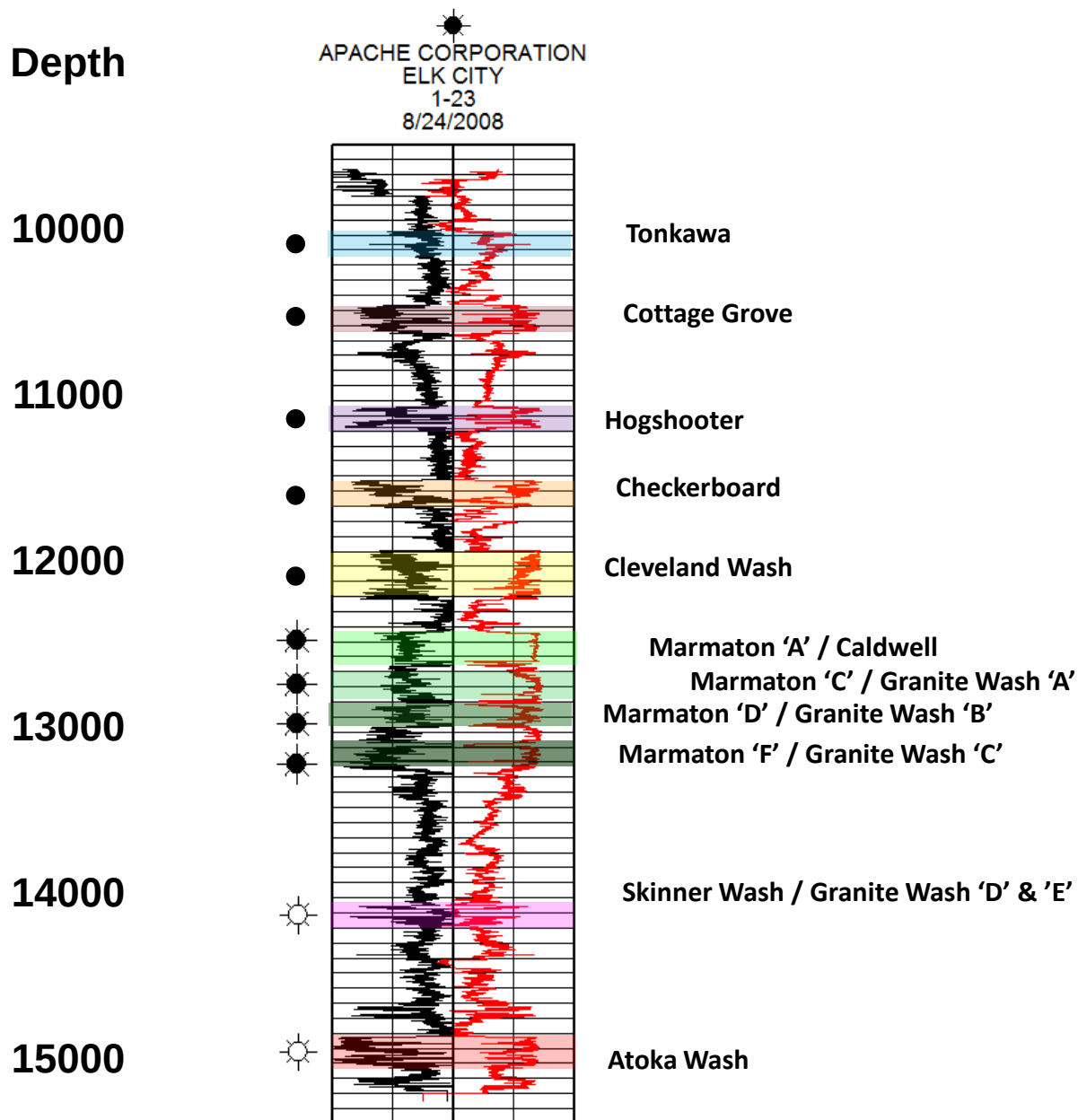


**Glenn Bone & Robbie Woodard**  
**1/19/2011**

# Central Overview



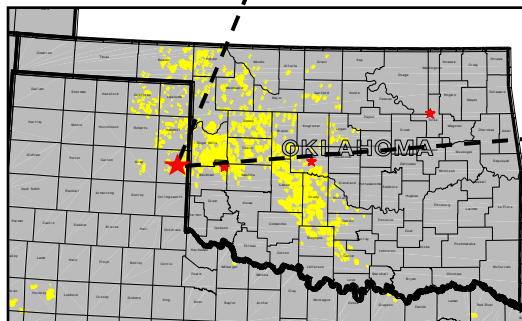
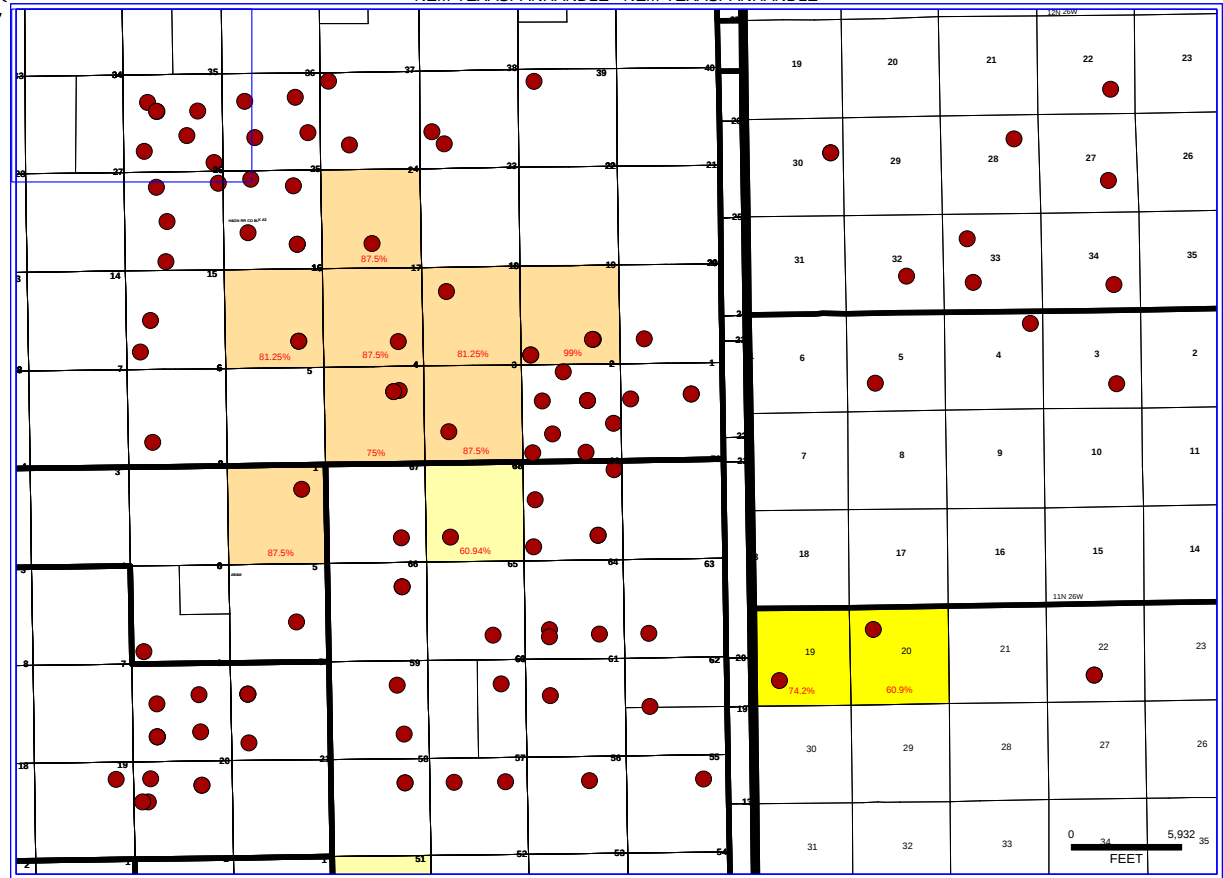
# Anadarko Basin Type Log



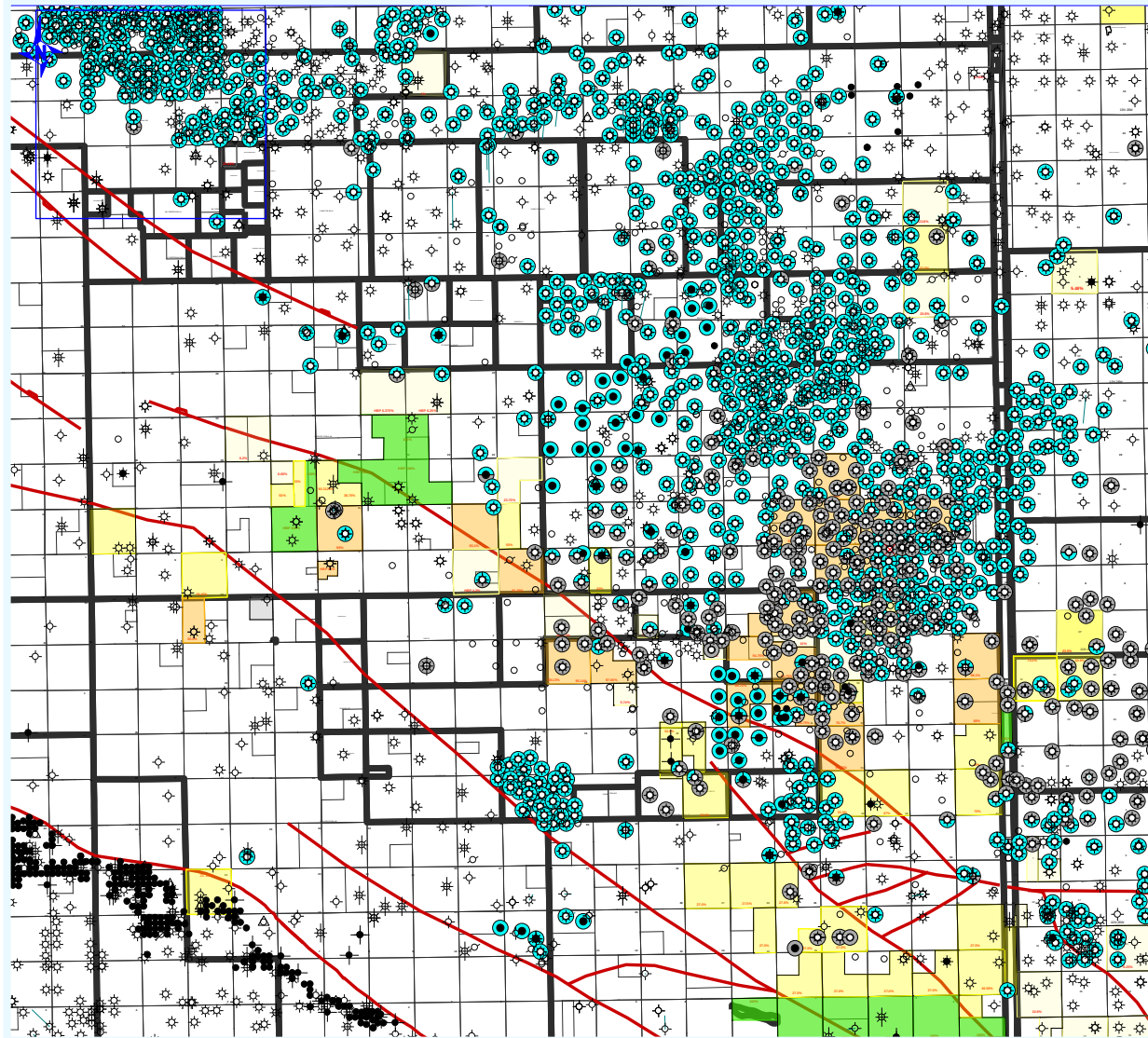
# Stiles Ranch Area 2003

1977 – 2003

10 Wells drilled



# ***Stiles Ranch Area Today***

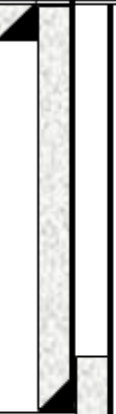


# Starting in 1977

| 18,000' Morrow |                                                                                     |  |  |           |                |
|----------------|-------------------------------------------------------------------------------------|--|--|-----------|----------------|
| MD             | Casing Profile                                                                      |  |  | Hole Size | Casing Details |
| 600'           |    |  |  | 26"       | 20"            |
| 5500'          |    |  |  | 17 1/2"   | 13 3/8"        |
| 13,800'        |    |  |  | 12 1/4"   | 9 5/8"         |
| 16,400'        |   |  |  | 8 1/2"    | 7 5/8"         |
| 18,000'        |  |  |  | 6 1/2"    | 4 1/2"         |

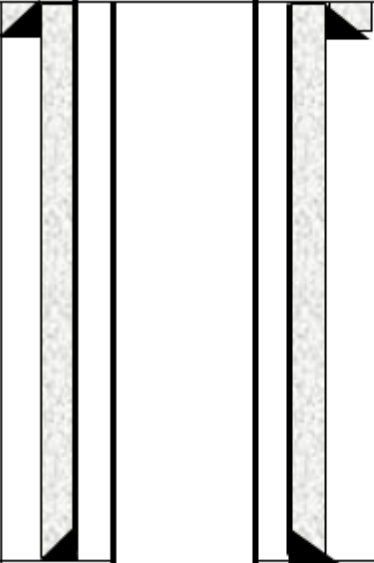
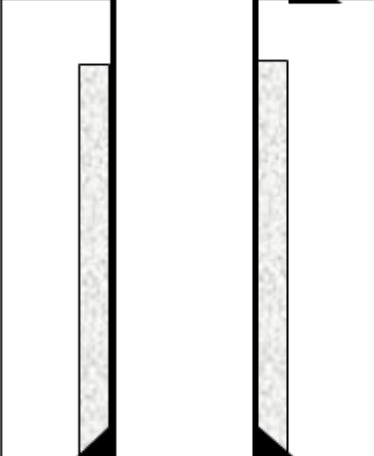
- Deep
- High Pressure (16-18 ppg mud)
- High volume
- Gas
- Minimal Completions

# GW Development 2004

| 14,000' GW |                                                                                     |                                                                                     |           |                |
|------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------|----------------|
| MD         | Casing Profile                                                                      |                                                                                     | Hole Size | Casing Details |
| 400'       |    |    | 17 1/2"   | 13 3/8"        |
| 3400'      |   |   | 12 1/4"   | 9 5/8"         |
| 14,000'    |  |  | 7 7/8"    | 4 1/2"         |

- Mid Range Depth
- Water Gradient
- Tight Rock
- Gas & Condensate
- Slick water Fracs

# Atoka Wash Development 2005

| 16,500' Atoka Wash |                                                                                     |  |           |                |
|--------------------|-------------------------------------------------------------------------------------|--|-----------|----------------|
| MD                 | Casing Profile                                                                      |  | Hole Size | Casing Details |
| 400'               |    |  | 17 1/2"   | 13 3/8"        |
| 8400'              |   |  | 12 1/4"   | 9 5/8"         |
| 16,500'            |  |  | 8 3/4"    | 4 1/2"         |

- Mid Range Depth
- Higher Pressures (TD with MW 11 ppg+/- 14.5 +/- ppg reservoir pressure)
- Tight
- Gas
- Slick water Fracs

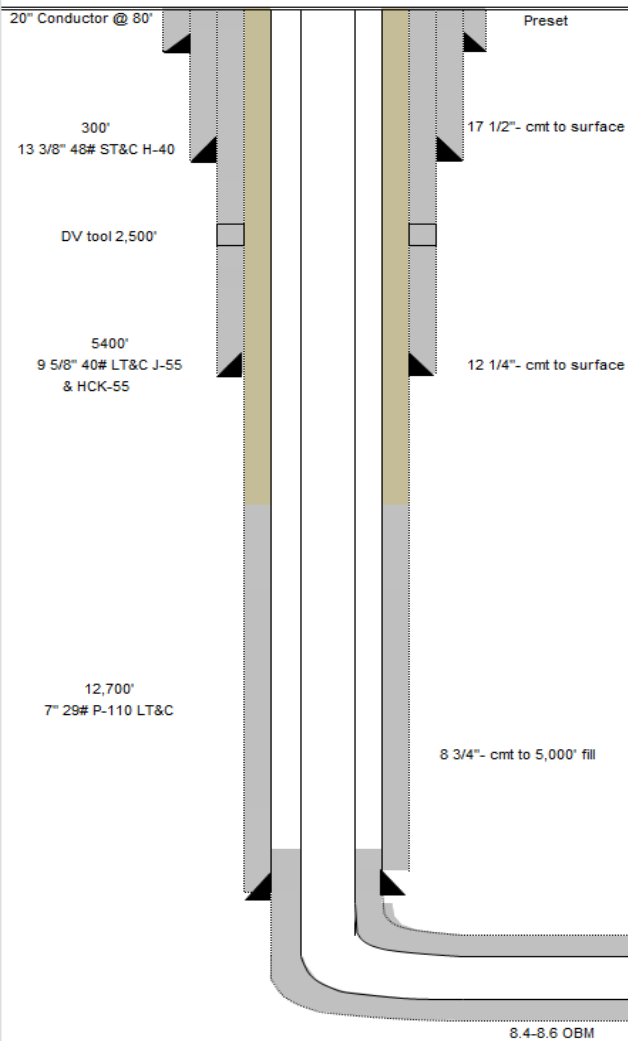
# ***Stiles Ranch & Texas GW***

|             |            |
|-------------|------------|
| Thick zones | > 1,500 ft |
| Porosity    | 6-12%      |
| Low perm    | 0.01 md    |
| Small DA's  | < 40 ac    |

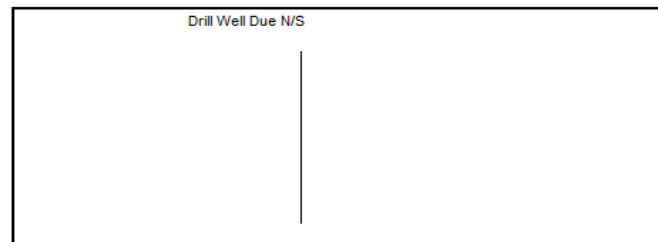
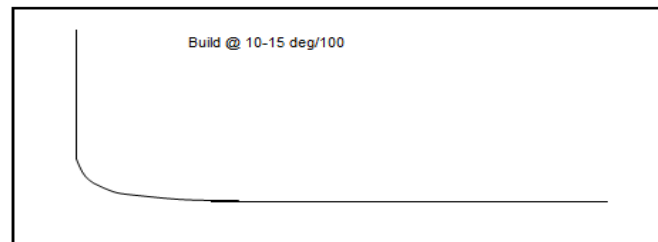


# GW Horizontals 2009

## Initial Design



### Directional Plan



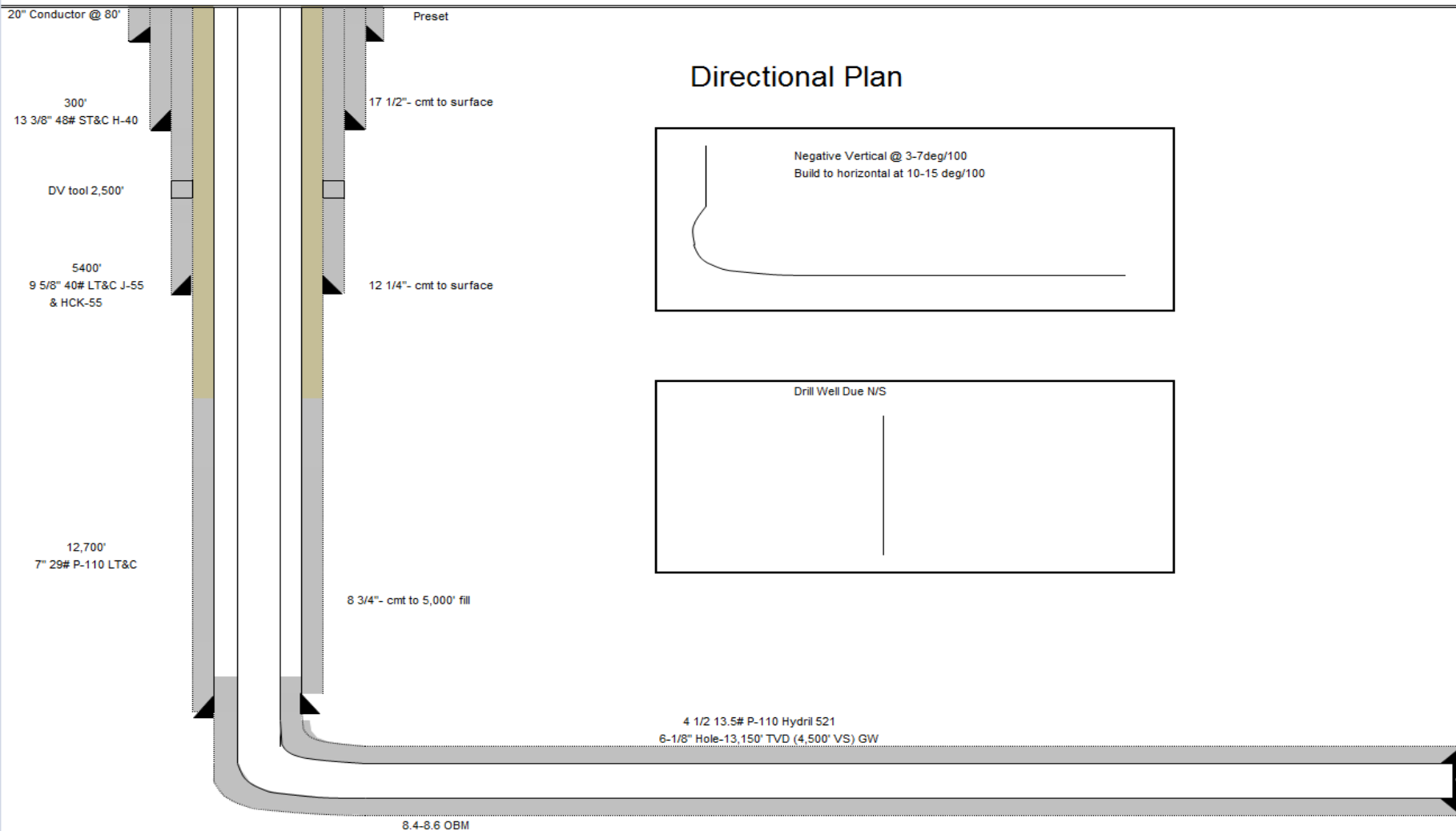
4 1/2 13.5# P-110 Hydril 521  
6-1/8" Hole-13,150' TVD (4,500' VS) GW

# ***Initial GW Horizontal Design***

- ◆ Goal to Test GW as a horizontal play
  - ◆ Set pipe near vertical above wash
  - ◆ Build 10-15 deg/100
  - ◆ 4,000' lateral
  - ◆ 8.5 OBM in lateral
  - ◆ LWD Logging
  - ◆ 43 Days to TD

# GW Horizontals 2009

## Negative Vertical Section Design

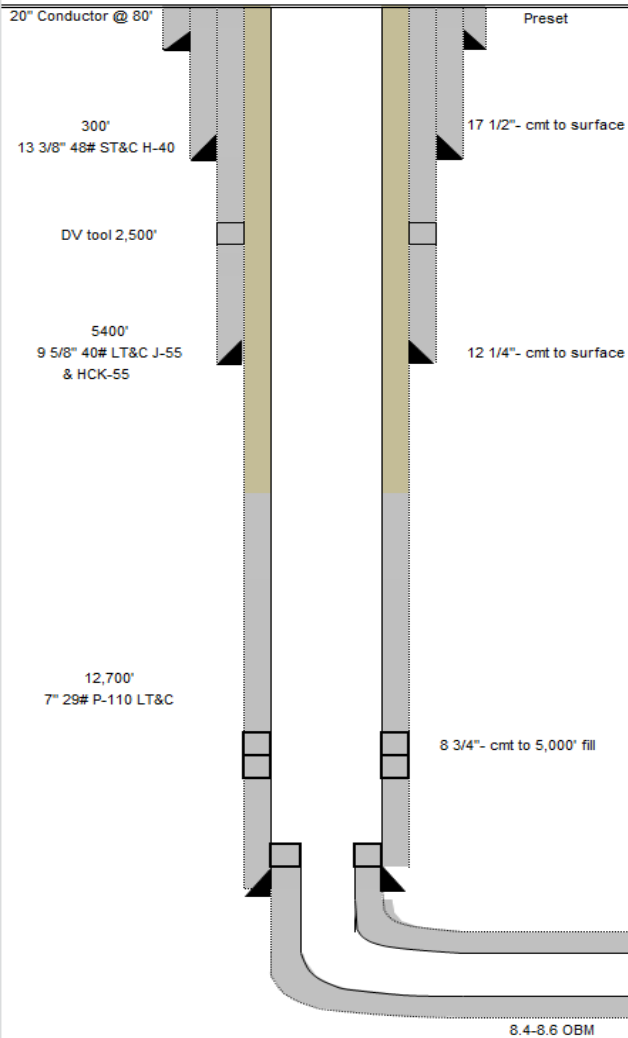


# ***Negative Vertical Section Design***

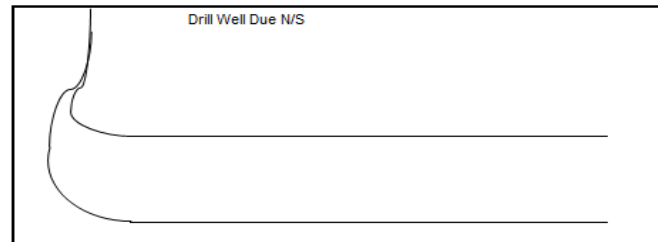
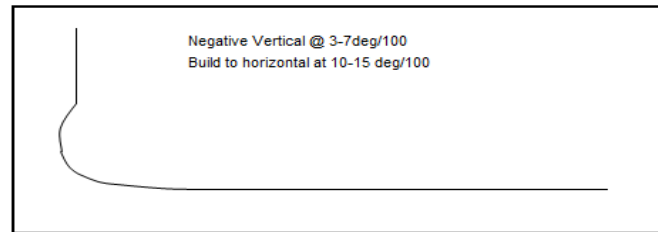
- ◆ Goal Improve GW economics by increasing lateral in zone
  - ◆ Negative Build 3-7 Deg, back to lease line
  - ◆ Build 10-15 deg/100
  - ◆ 4,500' lateral
  - ◆ 8.5 OBM in lateral
  - ◆ Shuttle logs
  - ◆ 47 Days to TD

# GW Horizontals 2010

## Latch Collar Design



### Directional Plan



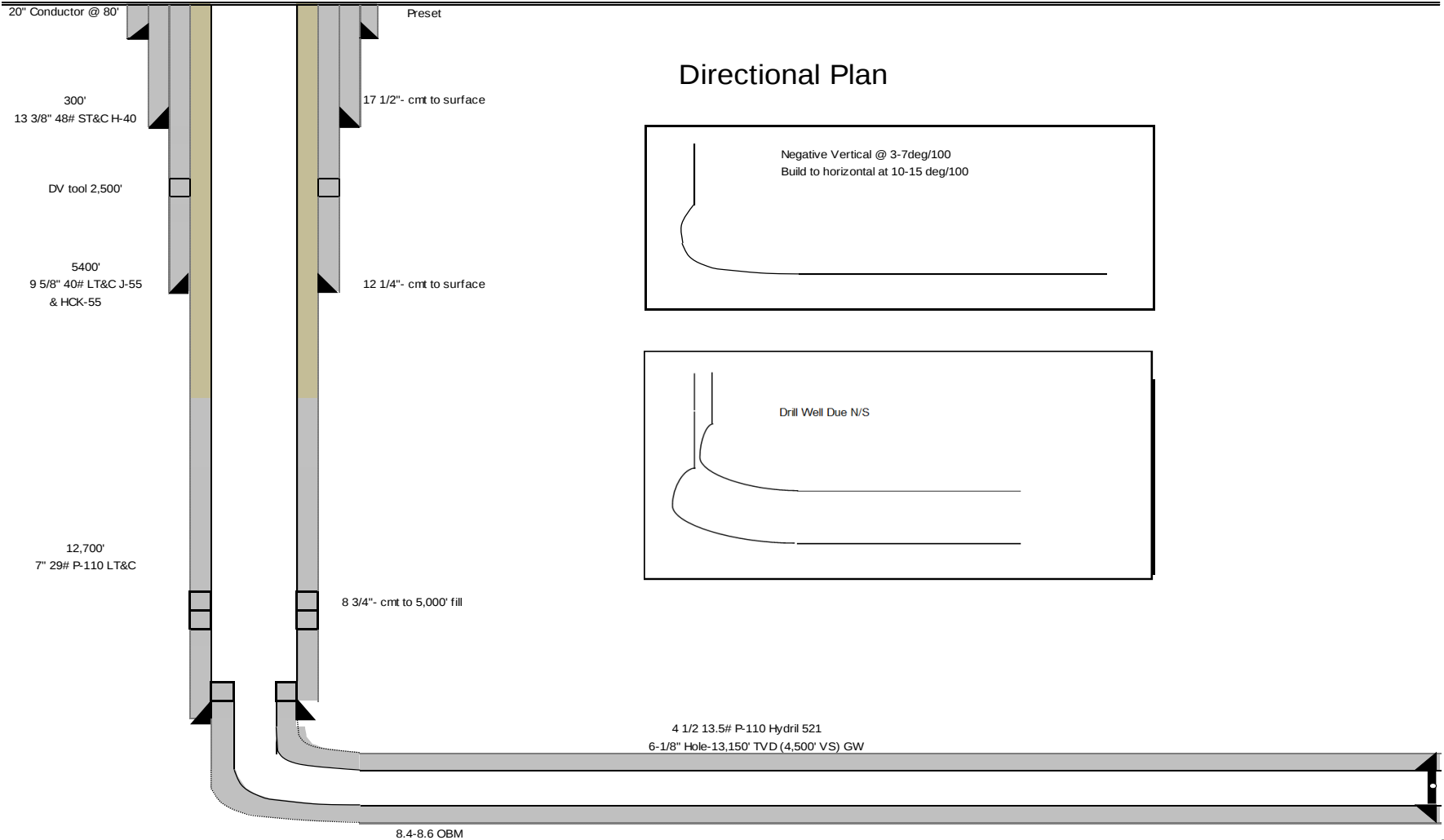
4 1/2 13.5# P-110 Hydril 521  
6-1/8" Hole-13,150' TVD (4,500' VS) GW

# ***Latch Collar Design***

- ◆ Goal design wells for multiple laterals
  - ◆ Negative Builds
  - ◆ Latch collars in 7"
  - ◆ Liner at TD
  - ◆ 47 Days to TD for the first lateral
  - ◆ 27 Days to TD for second lateral

# Stacked Lateral Design

## Stacked Lateral Design



# ***Stacked Lateral Design***

- ◆ Goal Increase wells per section
  - ◆ Negative Builds
  - ◆ Latch collars in 7"
  - ◆ New horizontal wells stacked under or over current producers
  - ◆ 48 Days to TD due to more directional work required

# ***Initial Well Changes***

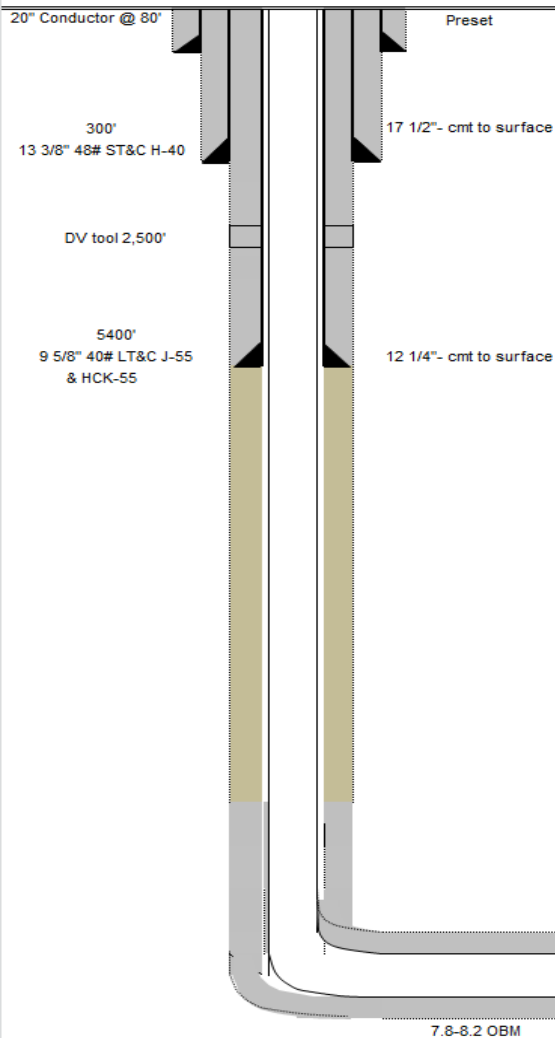
- ◆ Increased lateral length (improved economics)
- ◆ Added latch collars for future laterals
- ◆ Stacked lateral (increase number of wells per section)
- ◆ Well Changes
  - ◆ Improved Economics
  - ◆ Increased days on well
  - ◆ Increased cost of wells
  - ◆ Wells much more complicated

# ***Drilling Improvements***

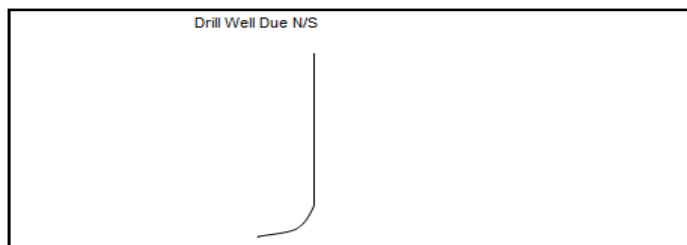
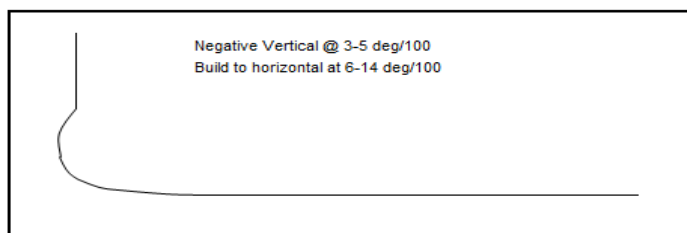
- ◆ Dropped MW to 8.0-8.2
- ◆ Soft land lateral
- ◆ Well Changes
  - ◆ Reduced OBM losses in lateral
  - ◆ Improved ROP In lateral (20%)
  - ◆ Reduced days on well to 46 (back to where we started)

# GW Horizontals 2010

## Drill thru Design



### Directional Plan



5 1/2 15.1# P-110 Hydriil 521 & BTC  
8 3/4" Hole-13,150' TVD (4,500' VS) GW

# ***Drill Thru Design & Goals***

- ◆ Goal reduce well cost and time
  - ◆ Water base thru loss zones
  - ◆ 5 ½" casing at TD
  - ◆ Stacked wells and Negative Build Vertical Section
  - ◆ Days to TD 42
  - ◆ Reduced well cost \$750,000
  - ◆ Improve pump pressures and complications for Completions

# ***Drill Thru Results***

- ◆ Drill Thru's
  - ◆ Stiles 68 17-68 – AFE \$3,808,002 Actual \$2,588,593 / Took 34 days 17,465' MD
  - ◆ Stiles 68 19-68 – AFE \$3,937,926 Actual \$2,695,355 / Took 33 days MD 15,679' / Lost 2000 bbls of OBM cut 2000 ft short
  - ◆ Stiles 68 20-68 – AFE \$3,926,039 Actual \$3,701,507 / Took 52 days MD 17,631'
  - ◆ Stiles 16 10-16 – AFE \$3,914,800 Actual \$3,649,423 / Took 50 days MD 17,819'
- ◆ Averages (Omit Stiles 68 19-68)
  - ◆ AFE: \$3,882,950
  - ◆ Actual: \$3,313,170
  - ◆ Days: 45

# ***Drill Thru Savings***

- ◆ Running 7 inch
  - ◆ Cost average: \$3,813,993 adjusted for rate increases
  - ◆ Averaging 49 days
- ◆ Savings: 4 days and \$500,000
- ◆ AFE'd without 7 inch
  - ◆ Weatherly #3-1H – AFE \$3,126,000 Actual 2,987,291
  - ◆ Took 39 days MD 15,707
  - ◆ Had major losses but ROP's as high as 60 ft/hr

# ***Problems & Solutions***

- ◆ What are the parameters for running 7 inch or attempting a drill thru?
- ◆ Water sensitive shale's & flow patterns
  - ◆ LSND vs. Dispersed
- ◆ When should you displace?
- ◆ Cost of losing OBM vs. running 7 inch

# ***Future***

- ◆ Improve PDC performance in Curve
- ◆ Reduce Slides
  - ◆ Adjustable Stabilizer
  - ◆ Change up BHA
- ◆ Attempt WBM if 7 inch is run
- ◆ Extended laterals in multiple sections

# Questions?

