# An Overview of the Williams Fork Geological Model and Supporting Reservoir Engineering Data for 10-acre Density Development

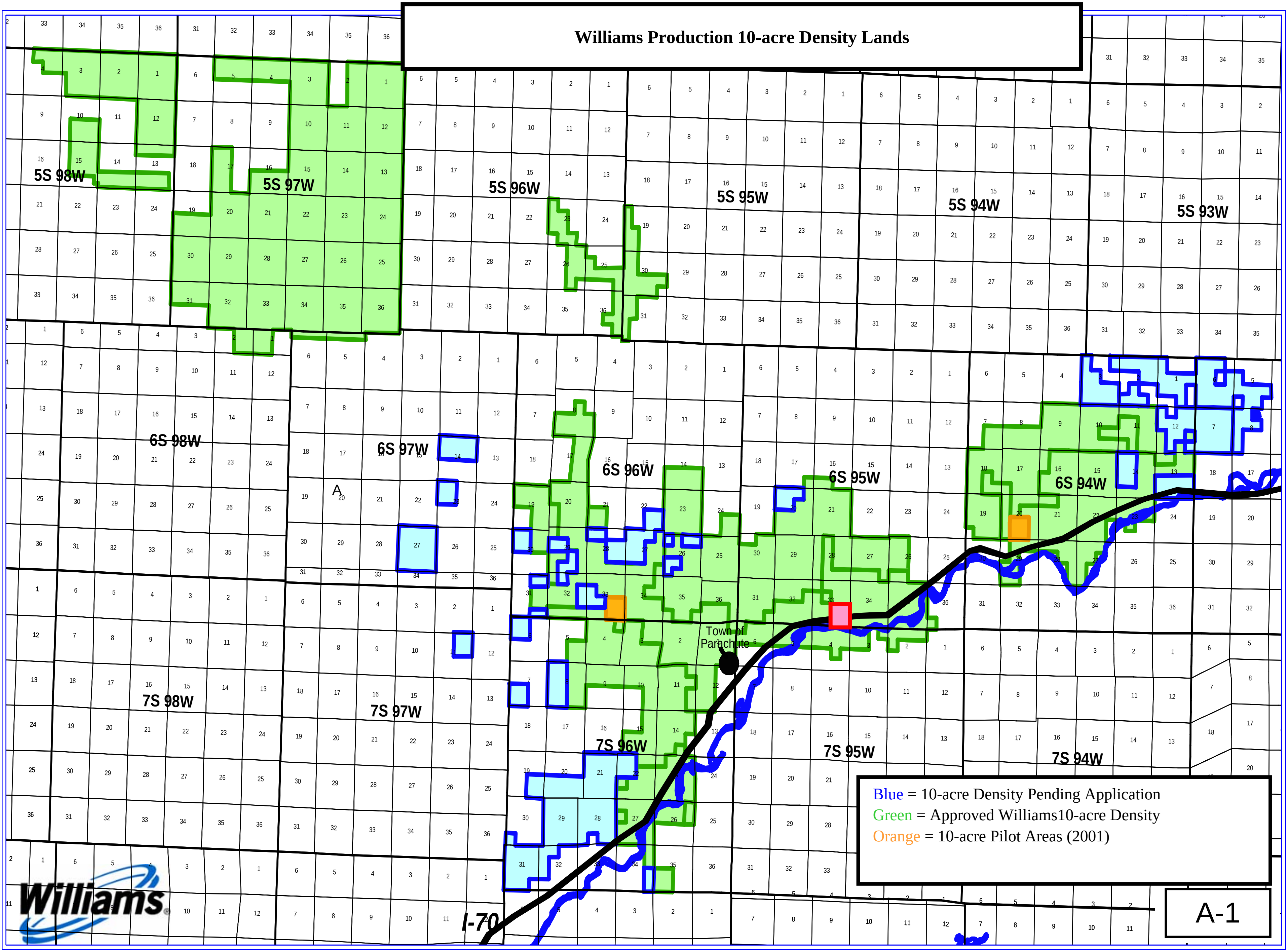
Presented to:

Colorado Oil and Gas Commission

Presented by:

Williams Production RMT Company

April 24, 2006



Williams Production 10-acre Density Lands
5S 98W
5S 97W
5S 96W
5S 95W
5S 94W
5S 93W
6S 98W
6S 97W
6S 96W
6S 95W
6S 94W
7S 98W
7S 97W
7S 96W
7S 95W
7S 94W
Town of Parachute
I-70
Blue = 10-acre Density Pending Application
Green = Approved Williams10-acre Density
Orange = 10-acre Pilot Areas (2001)
A-1
Williams

# GEOLOGIC MODEL OF THE WILLIAMS FORK FORMATION

1. THE GEOLOGIC MODEL SUPPORTS 10-ACRE DENSITY DRILLING.

2. YEARS OF VARIOUS STUDIES BY MANY DIFFERENT ORGANIZATIONS HAVE DEVELOPED AN IN-DEPTH GEOLOGIC MODEL.

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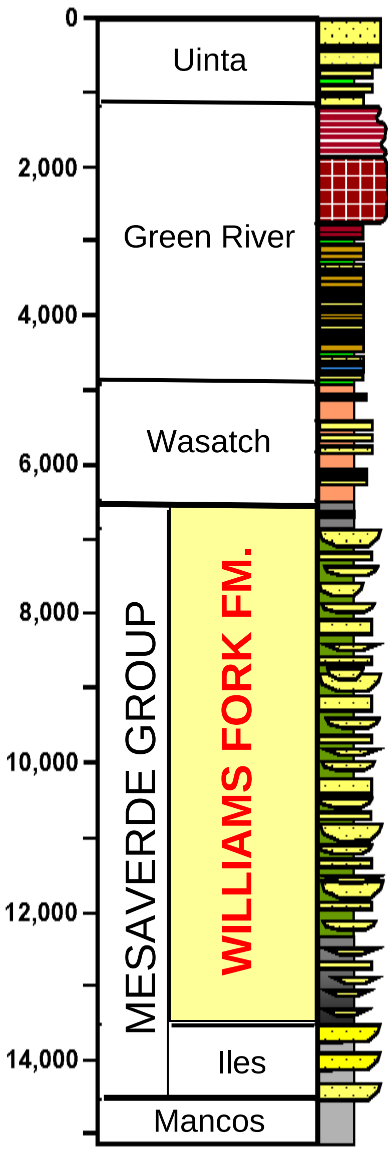
# BUILDING THE GEOLOGIC MODEL




STRATIGRAPHY

PALEOGEOGRAPHY

OUTCROP STUDIES

CORE ANALYSIS

MODERN-DAY ANALOGS

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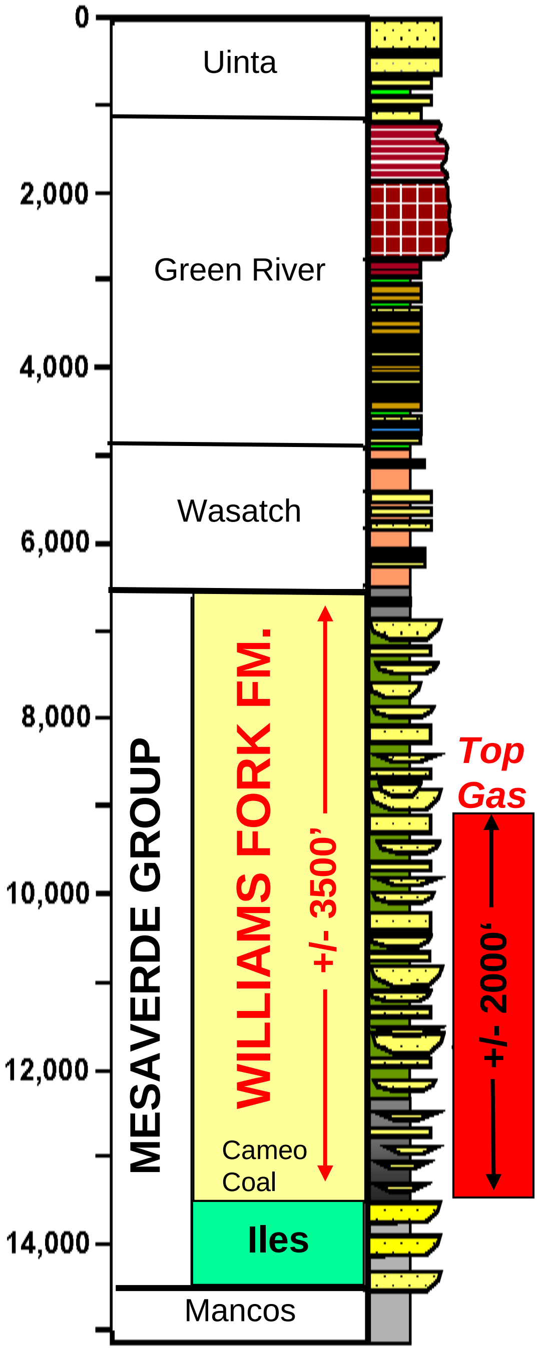
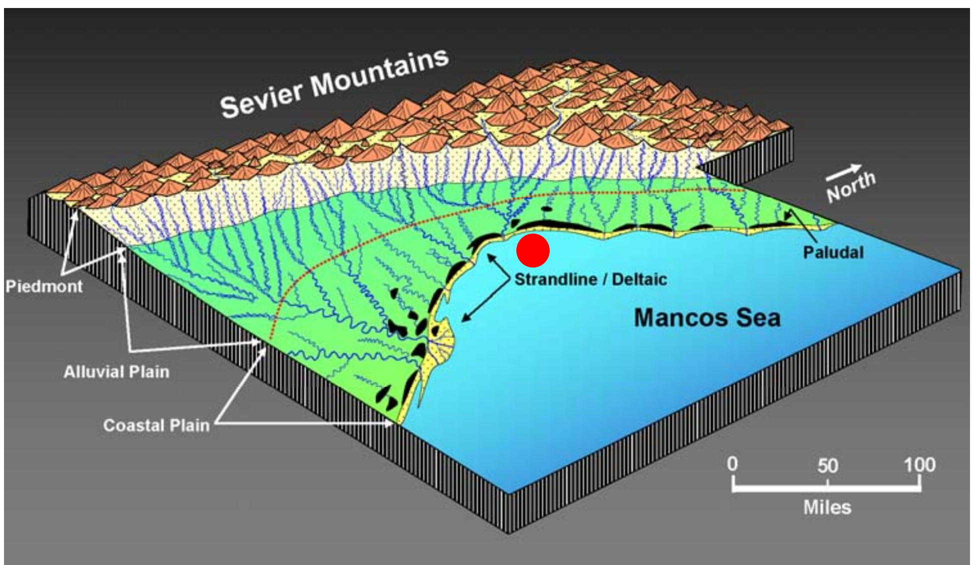
# THE GEOLOGIC MODEL SUPPORTS 10-ACRE DENSITY

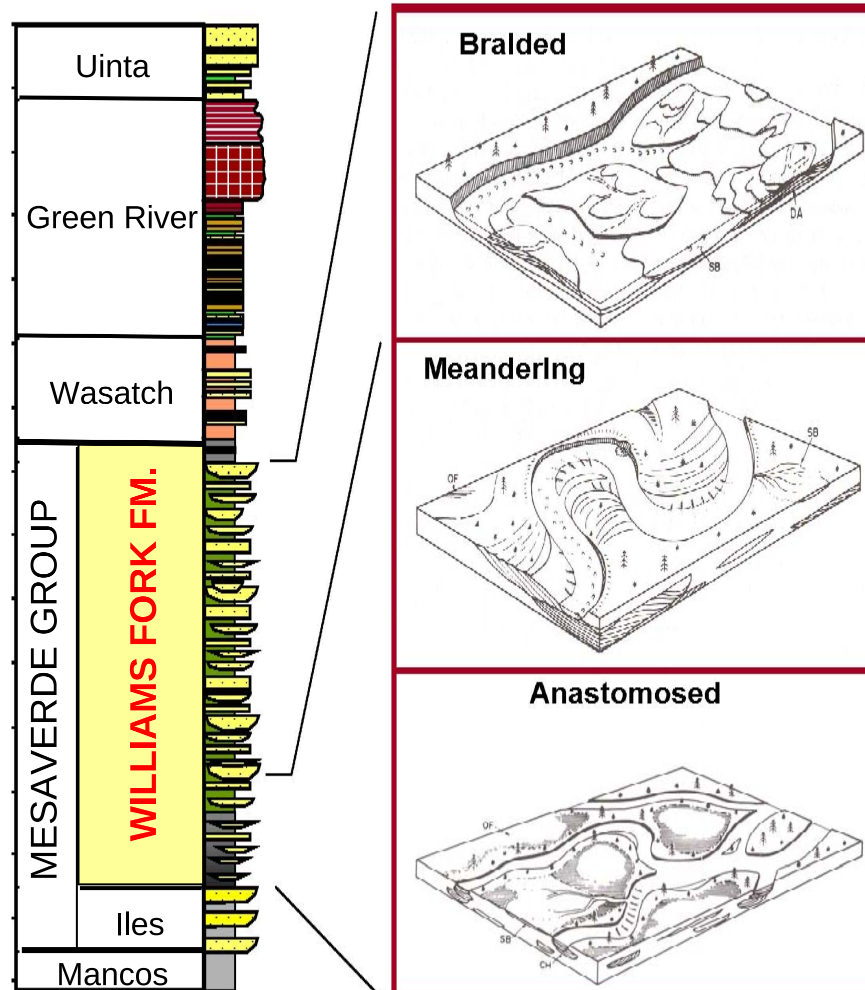



**Sand Body Characteristics:**

- Small and Discontinuous
  - Average apparent width = 526'
  - 10 acre = 660' between wells
- Complex Internal Structure
  - Many barriers to flow

# PALEOGEOGRAPHY OF THE WILLIAMS FORK FORMATION

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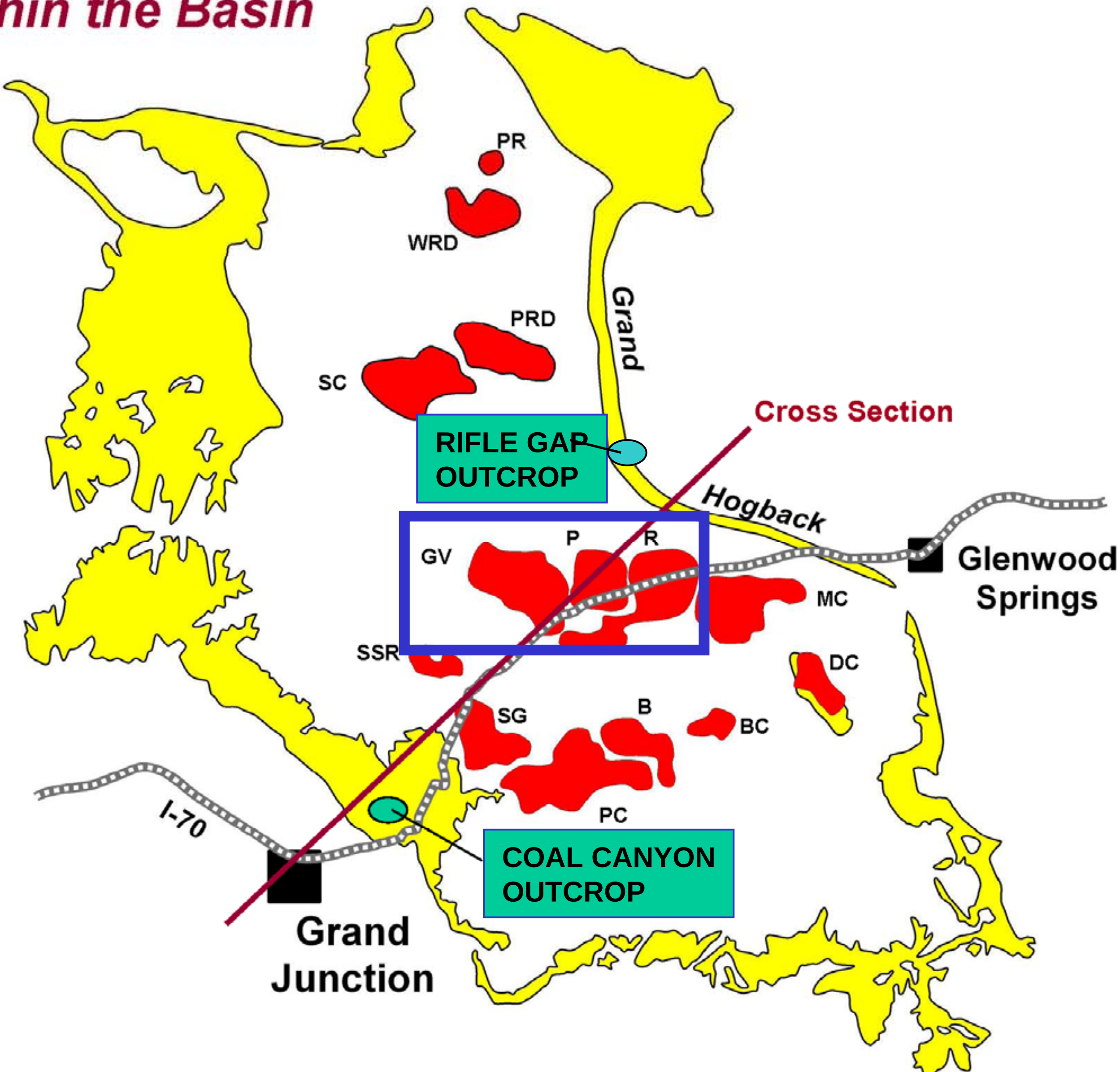
# Gas Fields Within the Basin




Modified from Johnson and Roberts (2003)

R.Cole (2005)

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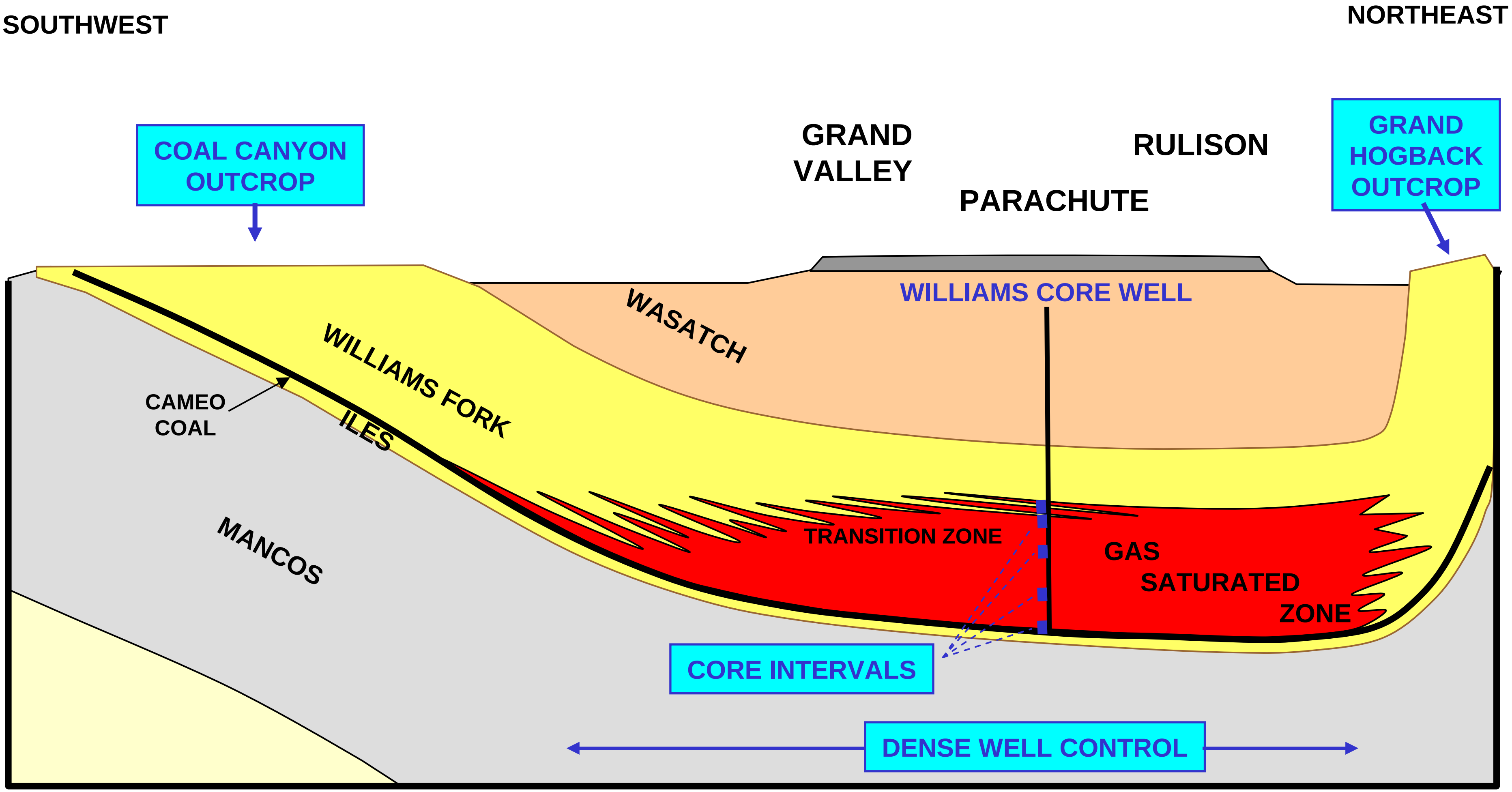
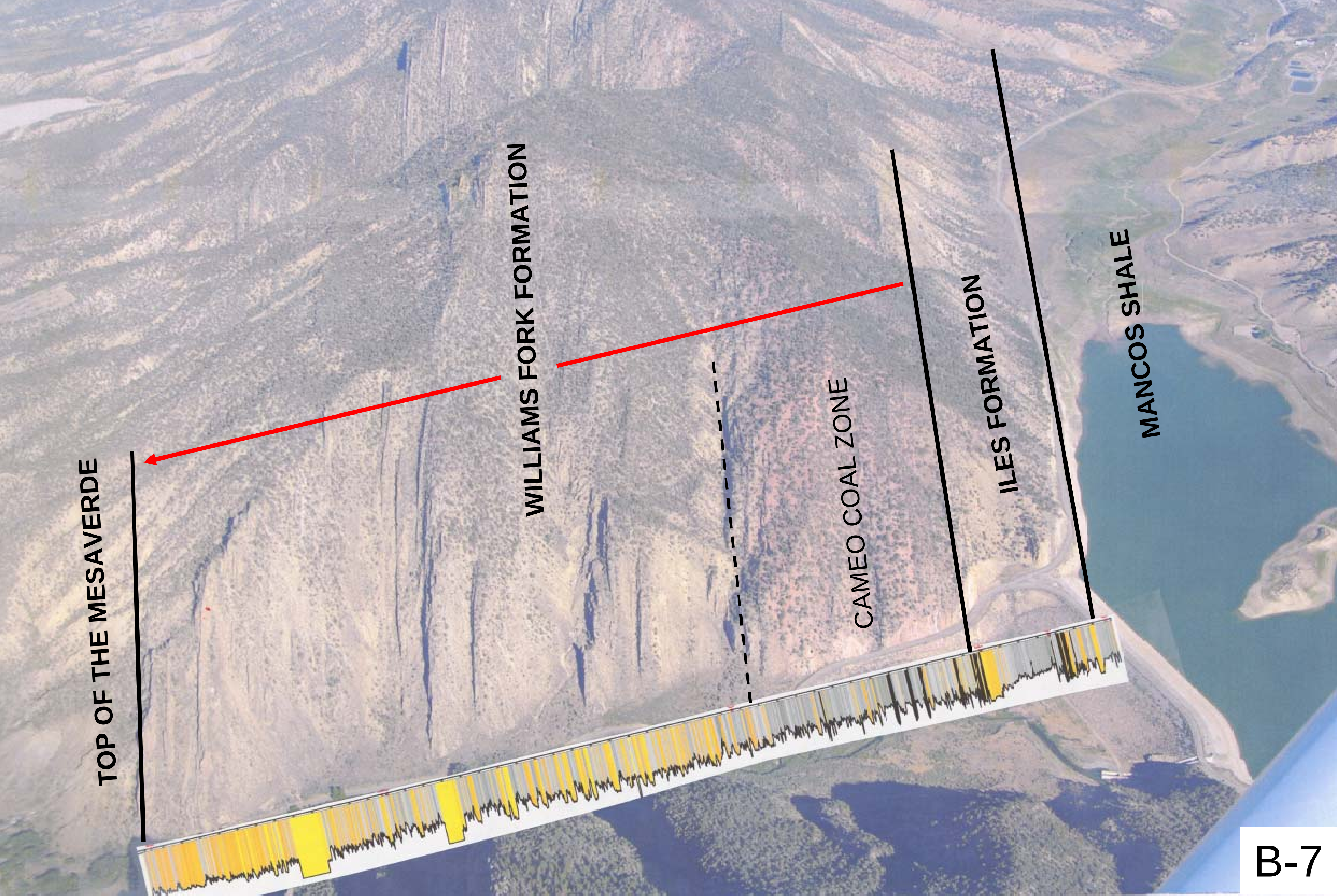
# SCHEMATIC CROSS SECTION - PICEANCE BASIN

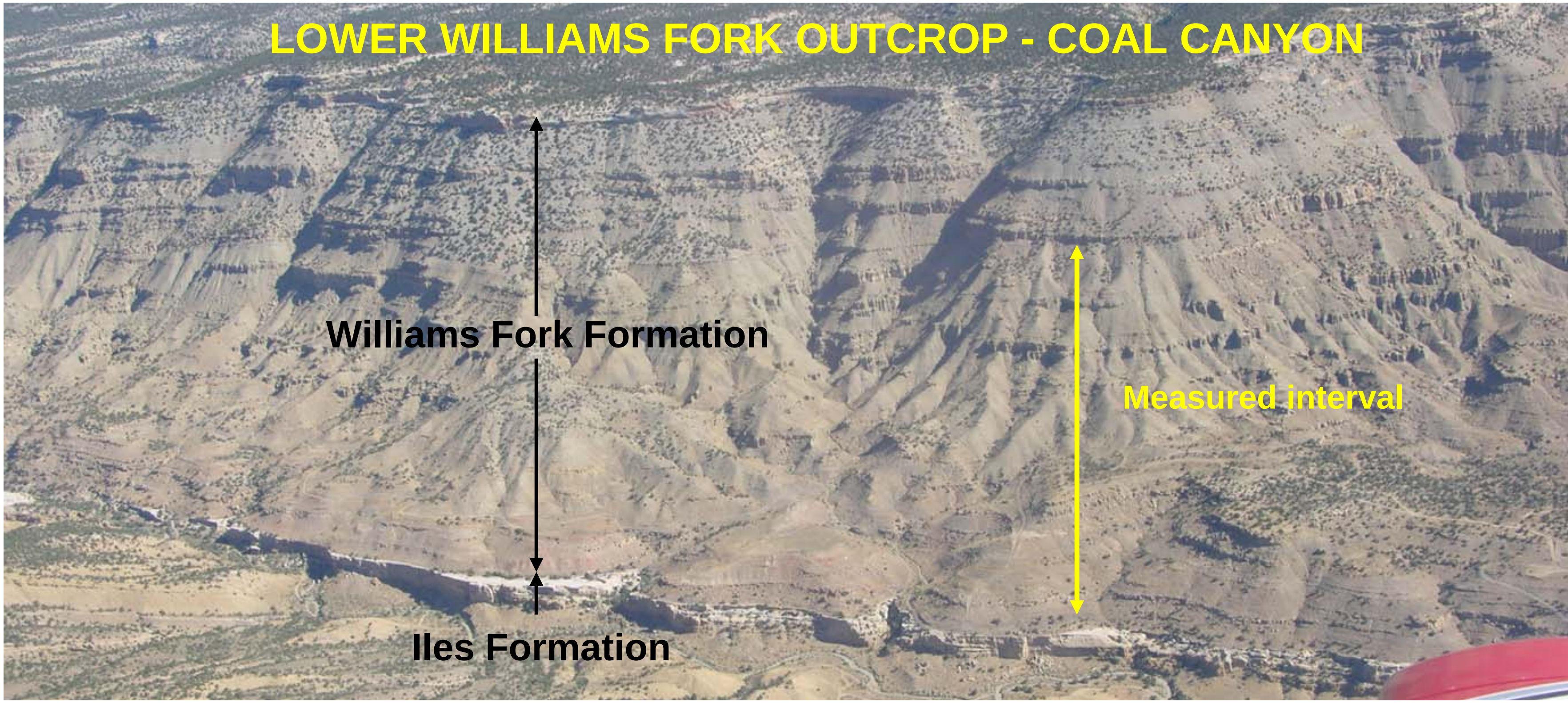



**Extensive outcrop around the basin, dense well control, and cored wells provide an exceptional opportunity to understand the reservoir in the subsurface and to support the geologic model.**

# WILLIAMS FORK FORMATION IN THE GRAND HOGBACK NEAR RIFLE GAP (EASTERN PICEANCE BASIN)

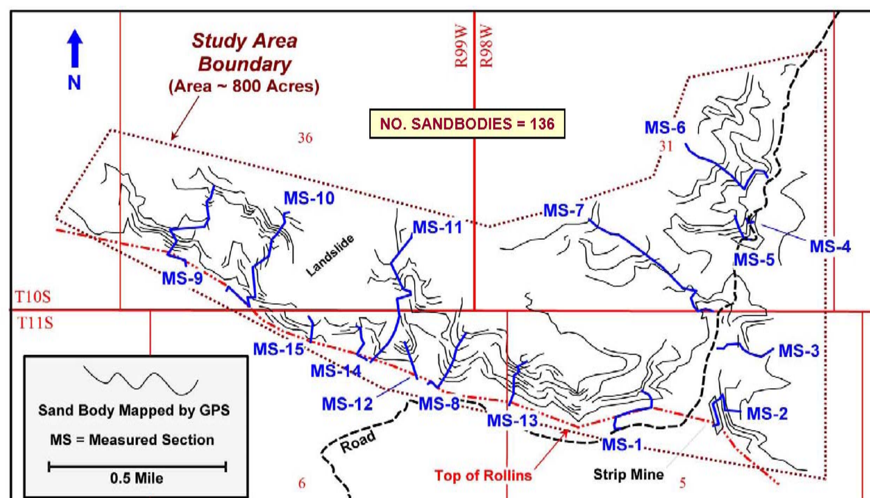


# LOWER WILLIAMS FORK OUTCROP - COAL CANYON




**Approximately 24 miles southwest of Grand Valley Field**

**Study of excellent outcrop exposures was undertaken to determine sand body widths**

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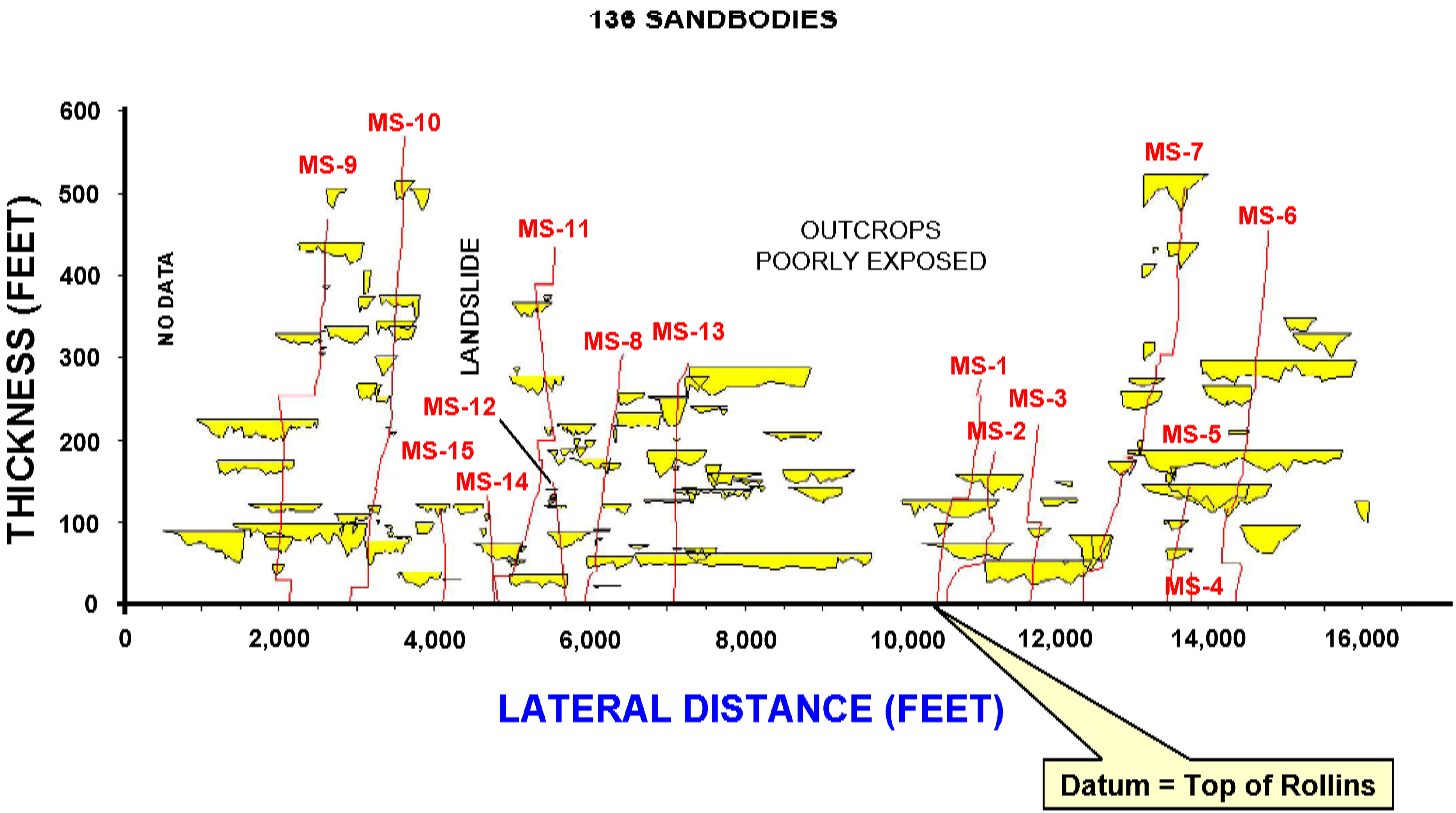
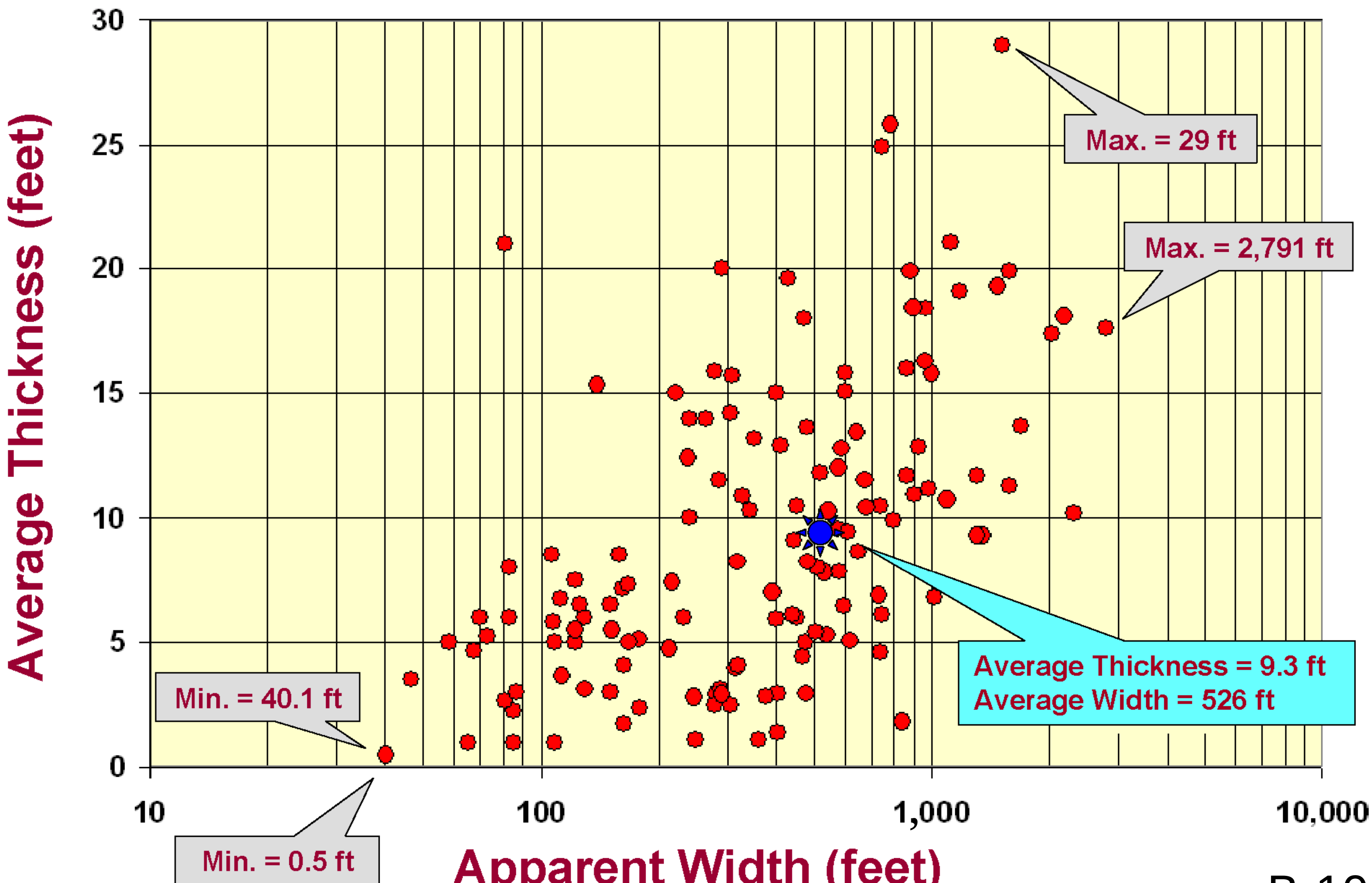
# Large-Scale Stratal Architecture



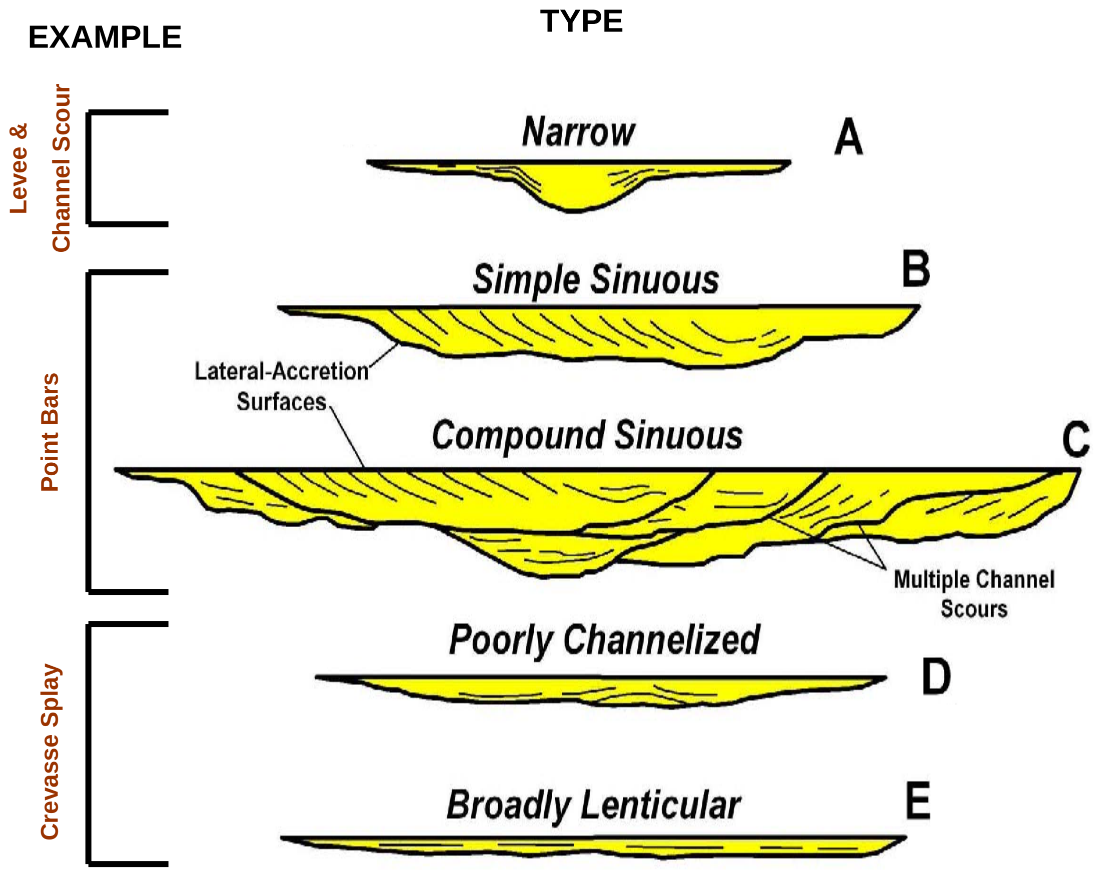
# Summary of Sand-Body Dimensions



# LOWER WILLIAMS FORK

# SAND BODY TYPES

## SAND BODY STATISTICS



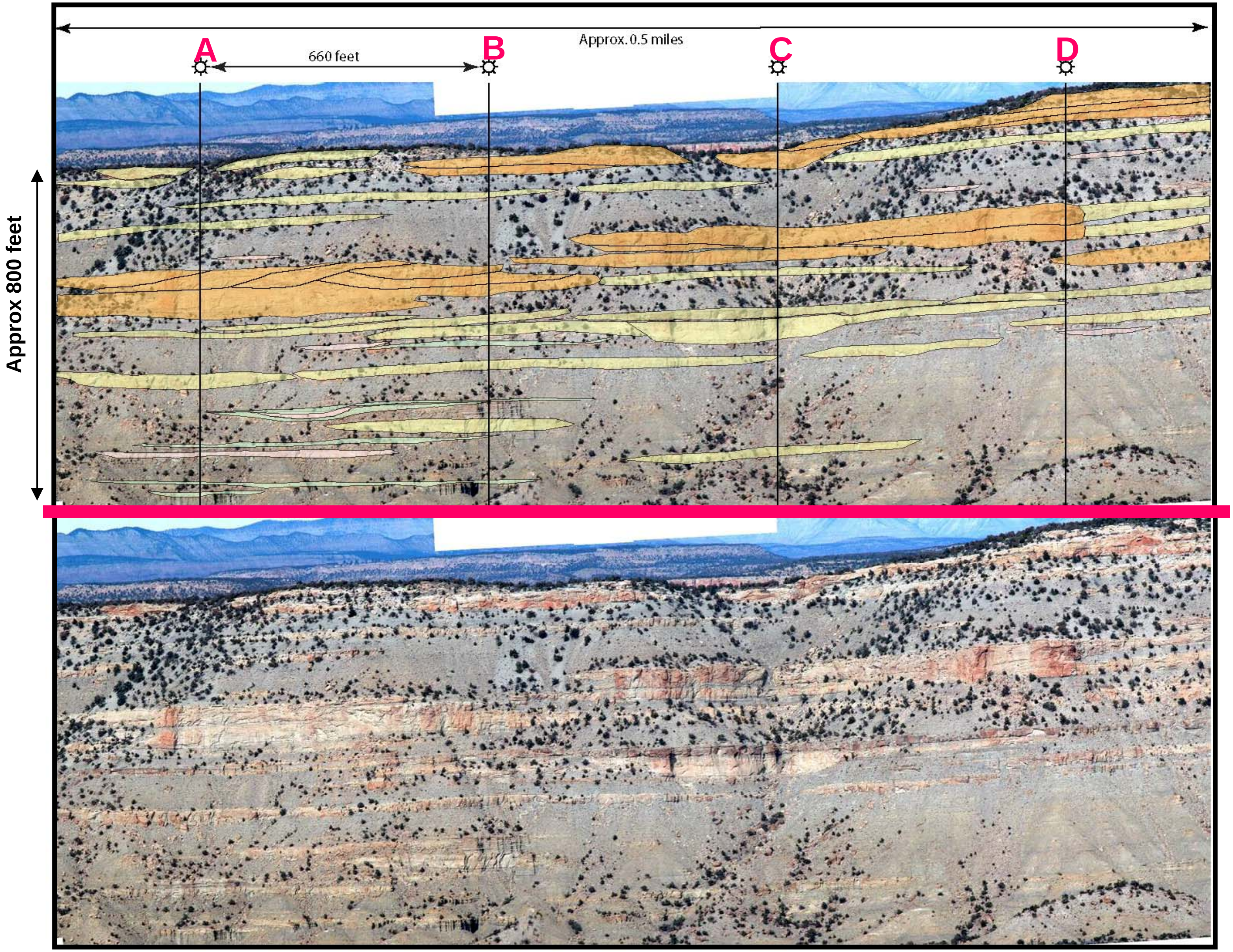

| N | Min | Max | Mean | Median |
|---|---|---|---|---|
| 9 | 3.5 | 21 | 9.2 | 6 |
| 9 | 46.4 | 290.5 | 98.5 | 81 |
| 30 | 4.1 | 18 | 8.8 | 7.7 |
| 30 | 112 | 2316.3 | 505.1 | 400.2 |
| 55 | 4.5 | 29 | 13.8 | 13.2 |
| 55 | 139.7 | 2791.1 | 814.8 | 674.3 |
| 14 | 2.5 | 9.1 | 5.4 | 5.4 |
| 14 | 72.9 | 510.4 | 234.8 | 165.4 |
| 28 | 0.5 | 6.5 | 2.8 | 2.8 |
| 28 | 40.1 | 843.3 | 275.7 | 247.4 |

**TOTAL POPULATION**

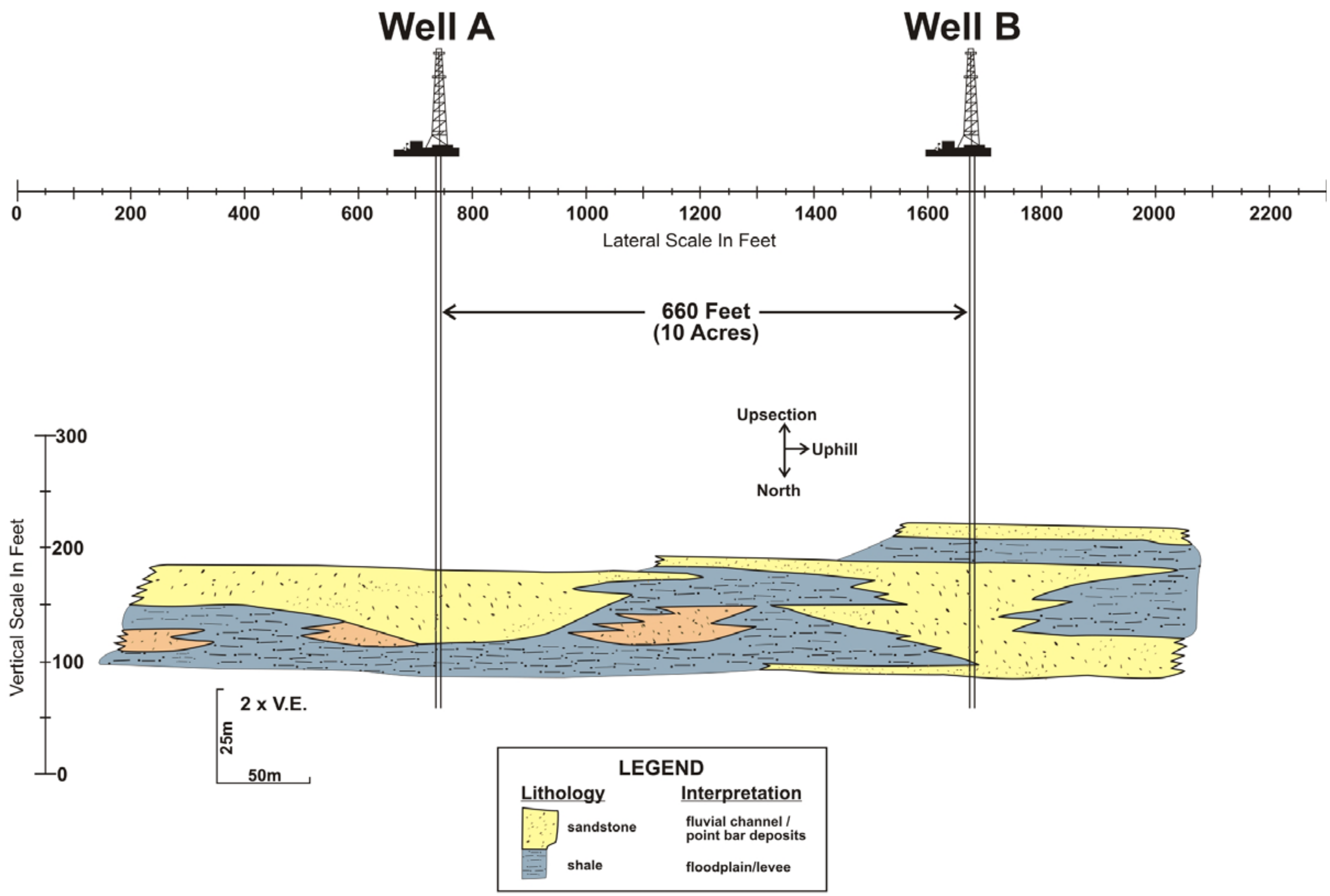
| | N | Min | Max | Mean | Median |
|---|---|---|---|---|---|
| **Thickness (ft)** | 136 | 0.5 | 29 | 9.3 | 8 |
| **Apparent Width (ft)** | 136 | 40.1 | 2791.1 | 526 | 400.2 |

*From Cole and Cumella (2005)*

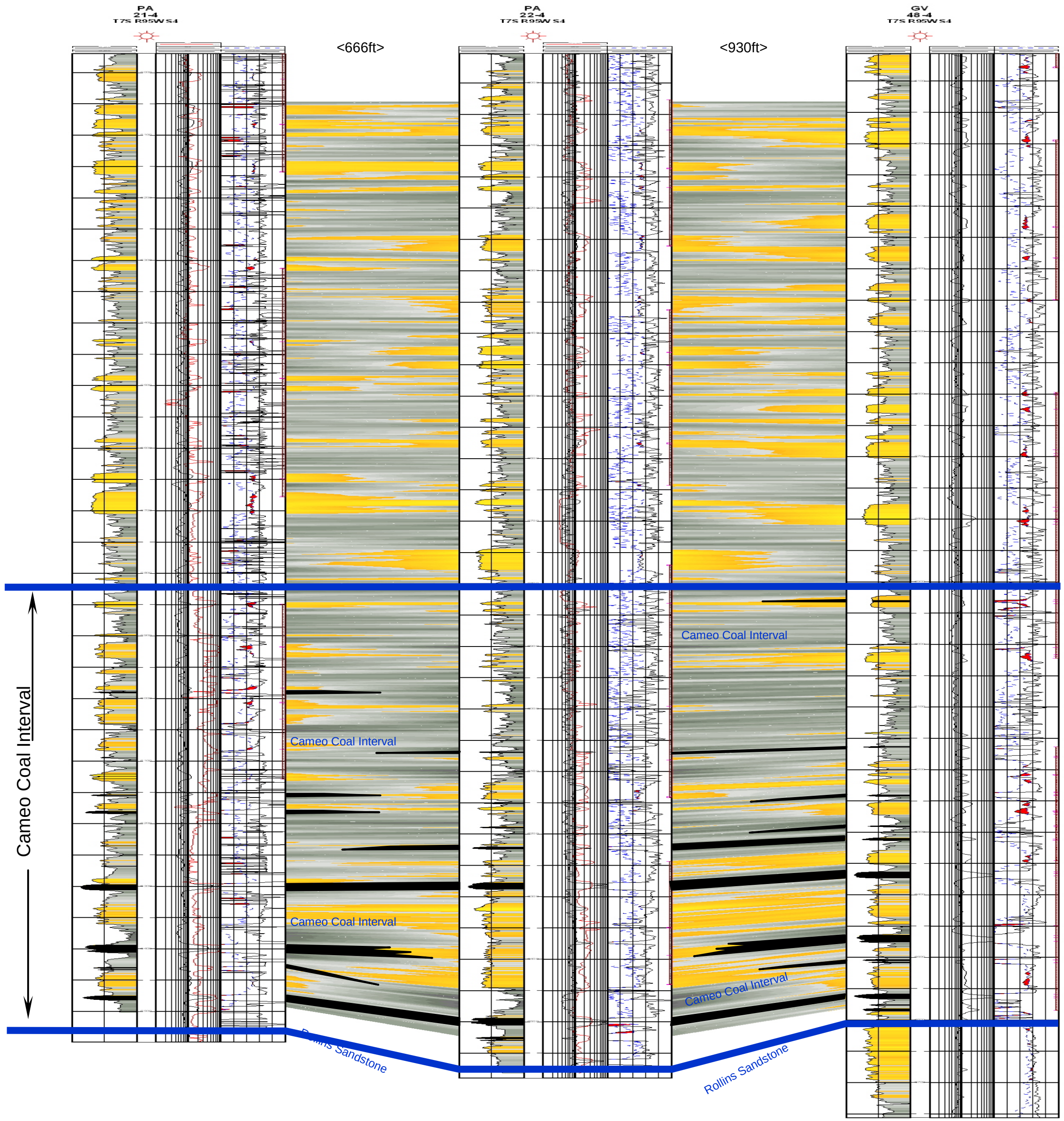
# WILLIAMS FORK IN COAL CANYON HIGHLIGHTING DISCRETE SAND BODIES



# Williams Fork Sandstone Bodies With Hypothetical 10-Acre Wells




*Outcrop of lens 8, west side of Rifle Gap, modified from Lorenz, 1982 (Pg. 28, Fig. 12).*



PA
21-4
T7S R95W S4
PA
22-4
T7S R95W S4
GV
48-4
T7S R95W S4
<666ft>
<930ft>
Cameo Coal Interval
Cameo Coal Interval
Cameo Coal Interval
Cameo Coal Interval
Cameo Coal Interval
Rollins Sandstone
Rollins Sandstone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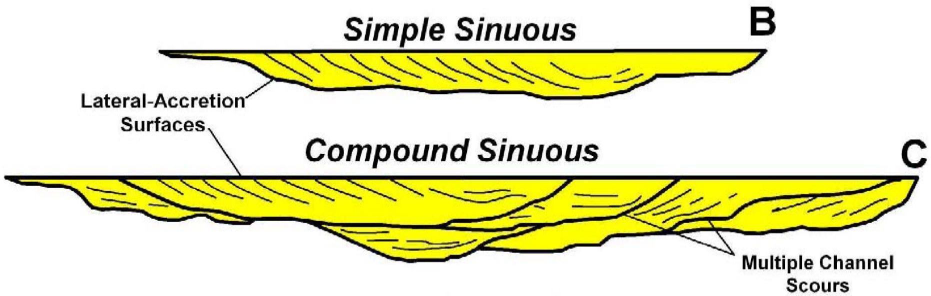
# MODERN DAY ANALOG
# POINT BARS IN THE SACRAMENTO RIVER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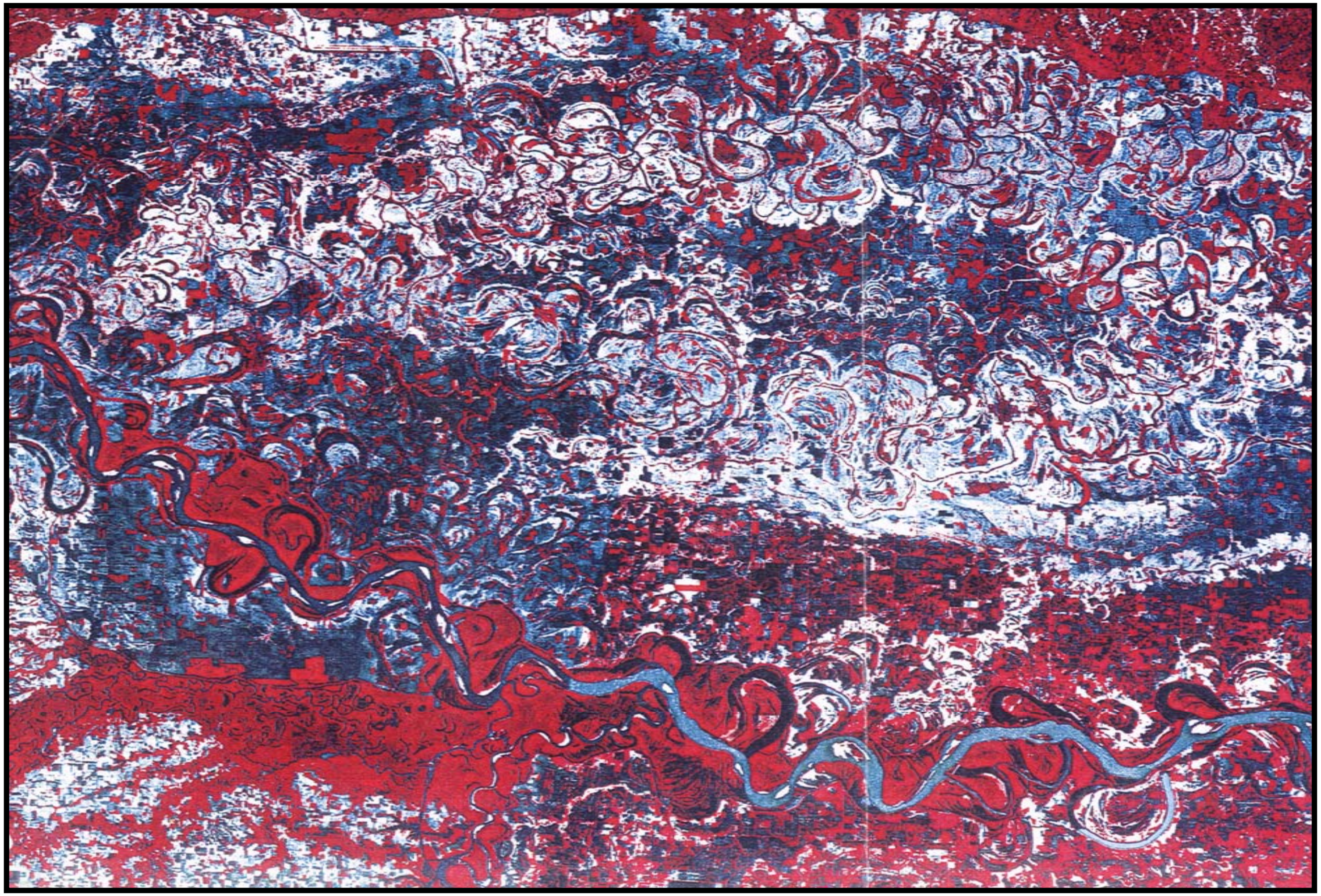
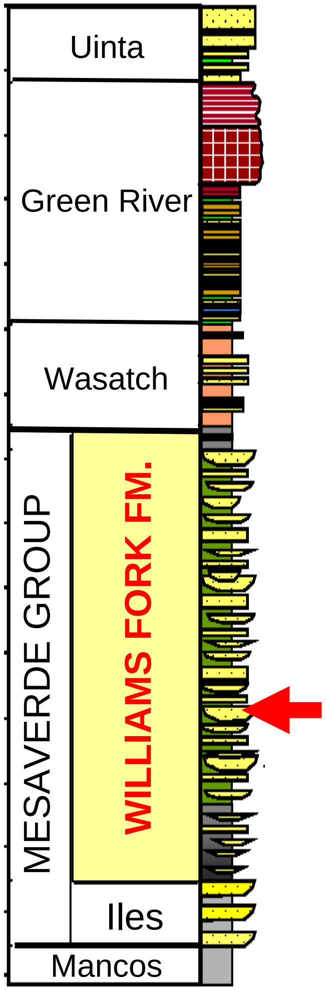
# MODERN ANALOG – MEANDERS AND POINT BARS IN THE MISSISSIPPI






- Hundreds of point bars (small, discontinuous sand bodies)
- A snapshot in time (repeated over and over in 3000' of Williams Fork)

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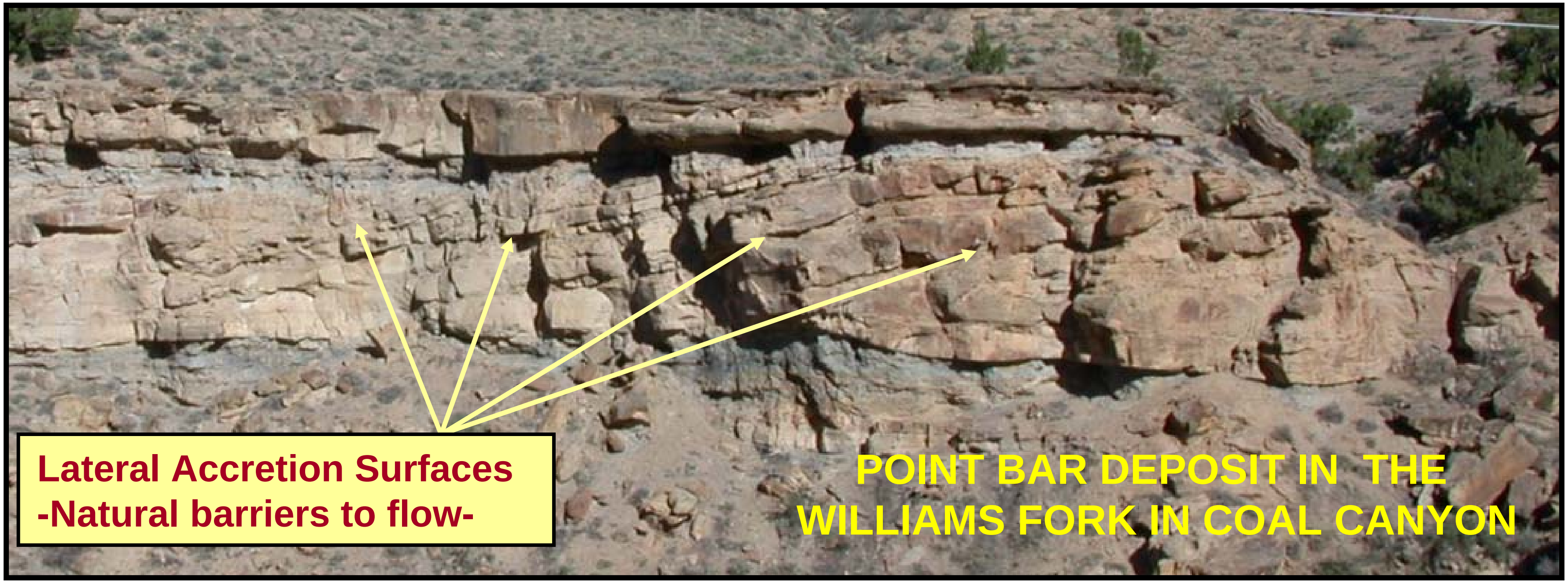
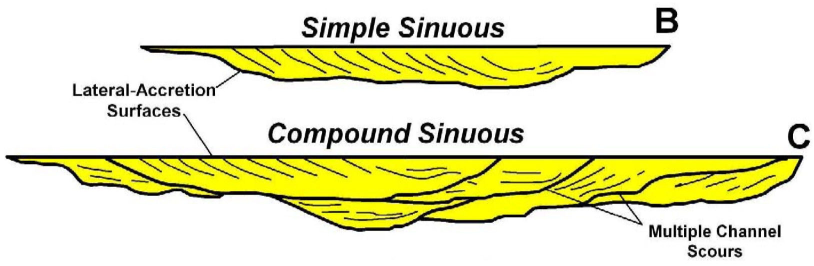
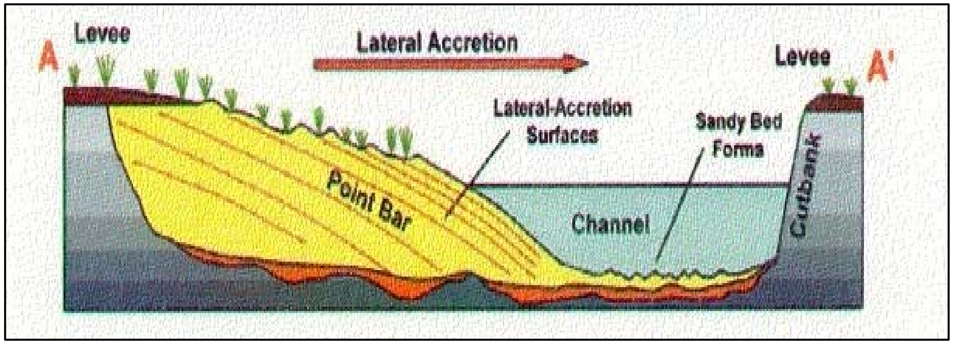
# SAND BODIES HAVE COMPLEX INTERNAL GEOMETRIES AND BARRIERS TO FLOW

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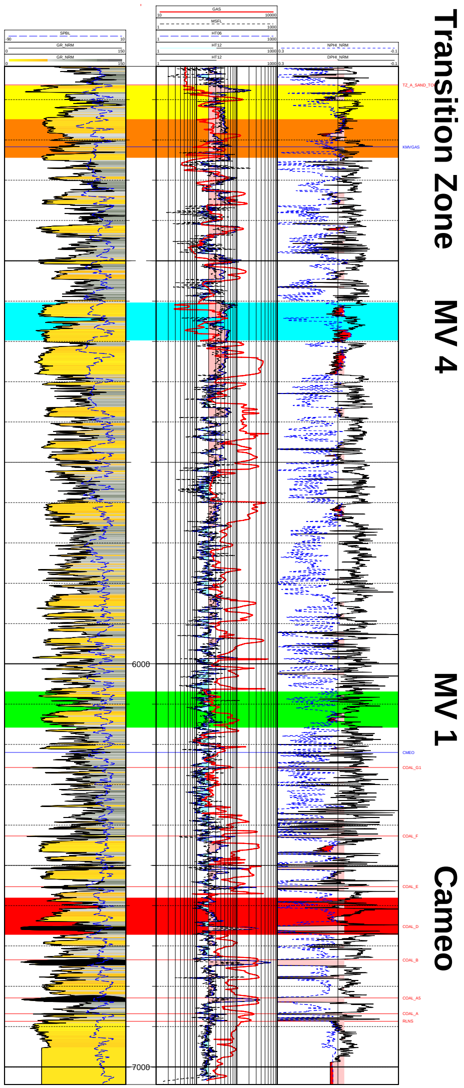
# Williams 2005 Core Program

- The depositional interpretations from the core study confirm the geologic model which was created using outcrop studies, dense well control, prior core work and modern day analogs.

- The geologic model is supported at all scales and depths of investigation.

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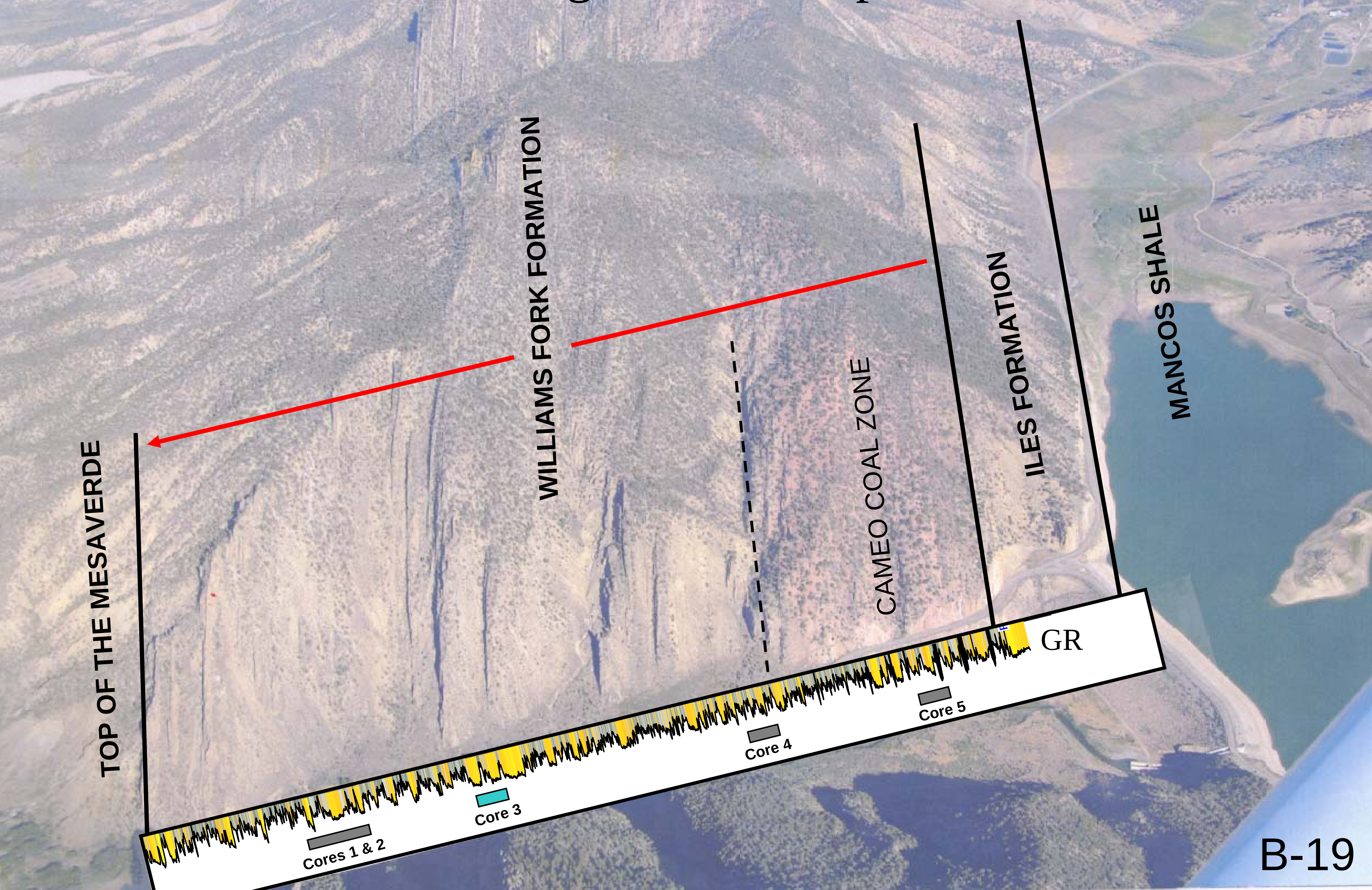
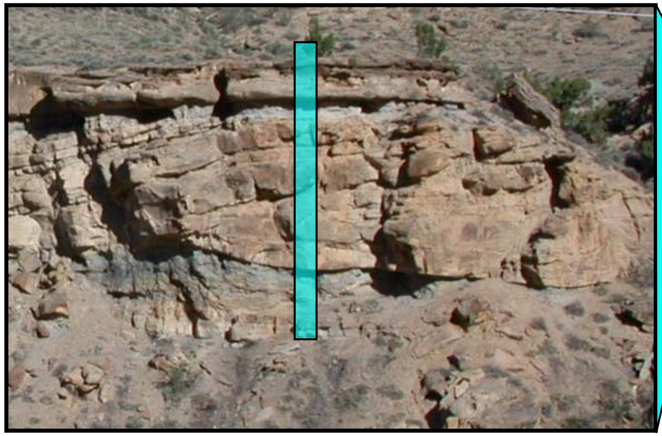
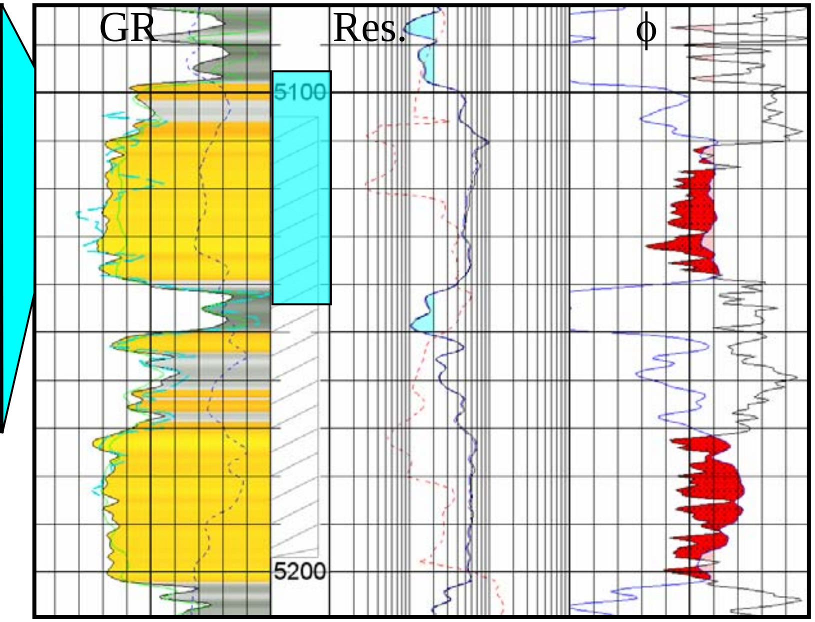
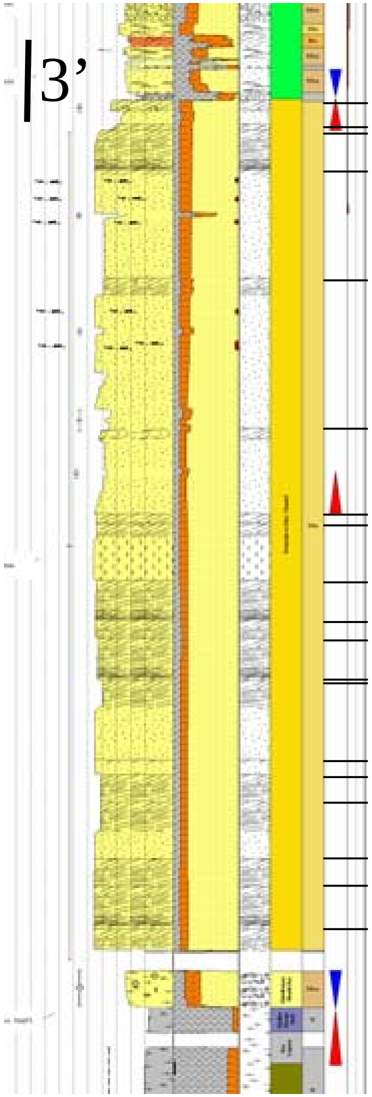
# Schematic of Williams' Cored Well on the Grand Hogback Outcrop



# Outcrop to Subsurface Example






- Note multiple surfaces in outcrop and core that may act as barriers to flow.
- "Lazy" character on conventional log data betrays the internal complexity.

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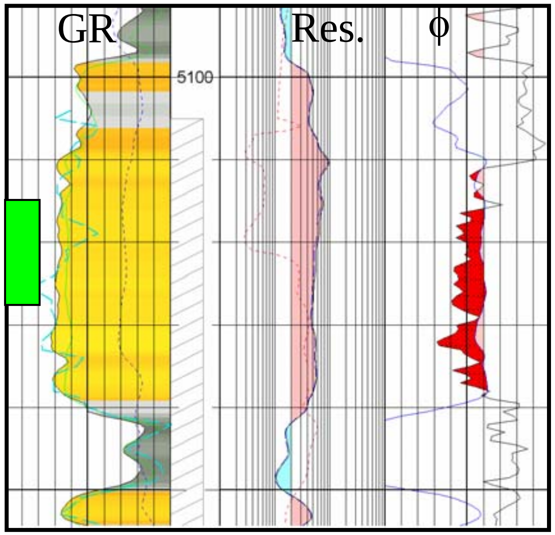
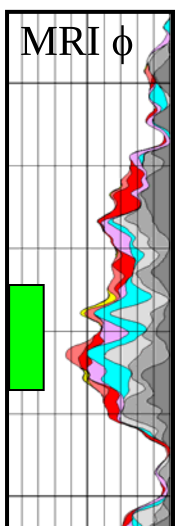
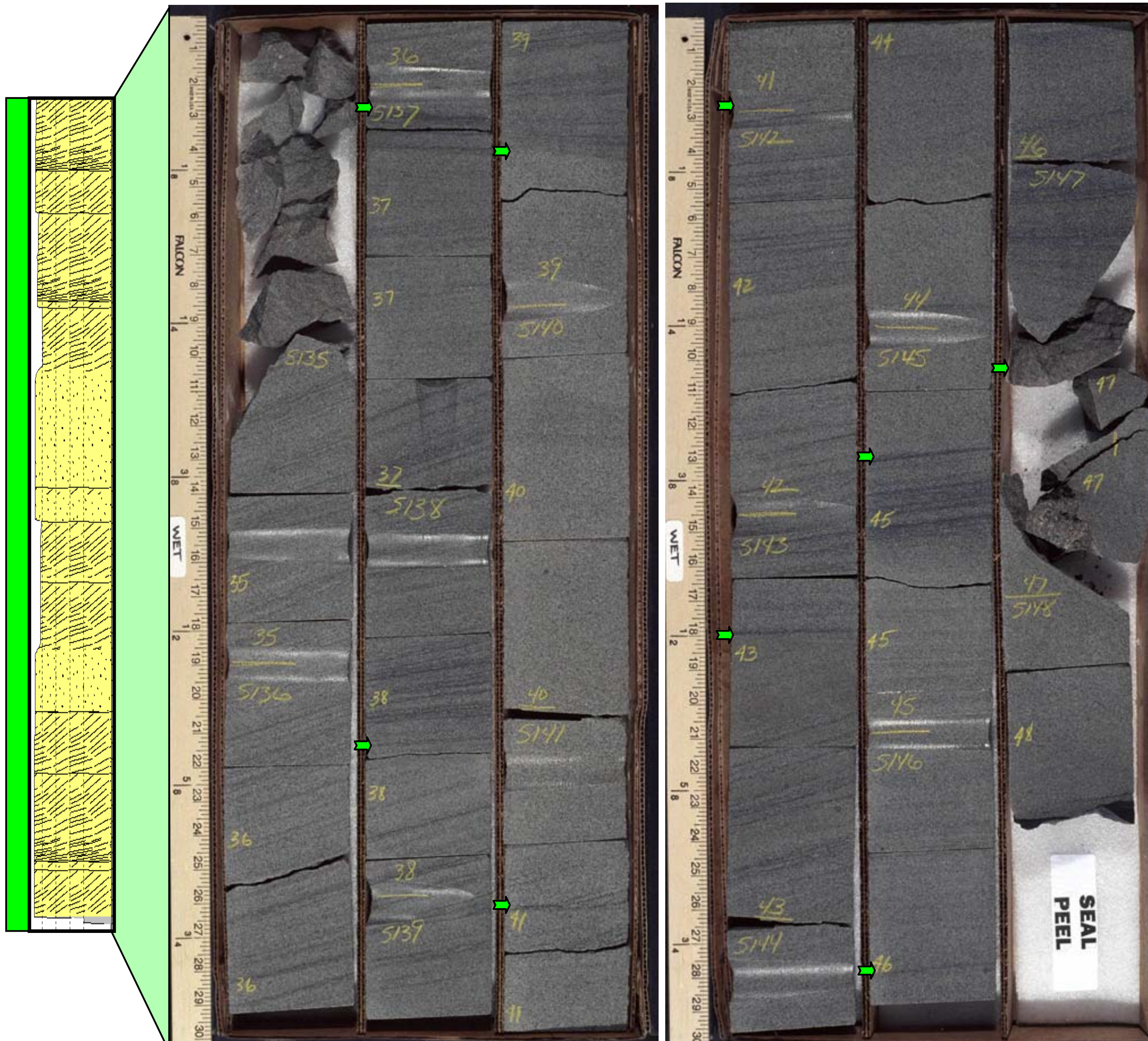
# Core Description and Finer Scaled Features



# Geologic Model Summary

- Discontinuous sand bodies of limited aerial extent were deposited in fluvial settings.
- Average apparent sand body width is 526’.
- Without 10-Acre density drilling, a significant number of sand units would never be penetrated, leaving considerable gas behind.
- Natural discontinuities exist within the sand bodies that are barriers to flow.
- Extensive outcrop around the basin, dense well control, and cored wells provided an exceptional opportunity to develop this in-depth geologic model.

# 10-Acre Pilot Summary

| | Grand Valley | Rulison | Total |
|---|---|---|---|
| Acres: | 160 | 160 | 320 |
| Existing Wells: (20-Acre Well Density) | 8 | 8 | 16 |
| Wells Drilled: (10-Acre Well Density) | 8 | 8 | 16 |
| Pressure Tests: (Individual Sands) | 96 | 125 | 221 |
| Microseismic Monitored Hydraulic Fracs: | 6 | 8 | 14 |

Other Tests: 4 Production Logs, 7 RFT tests, 4 FMI logs

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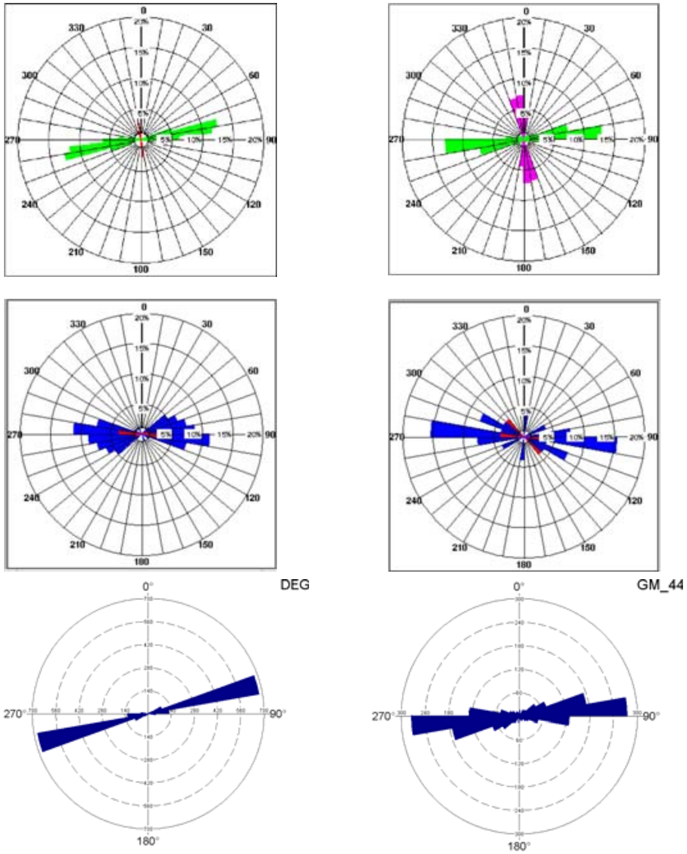
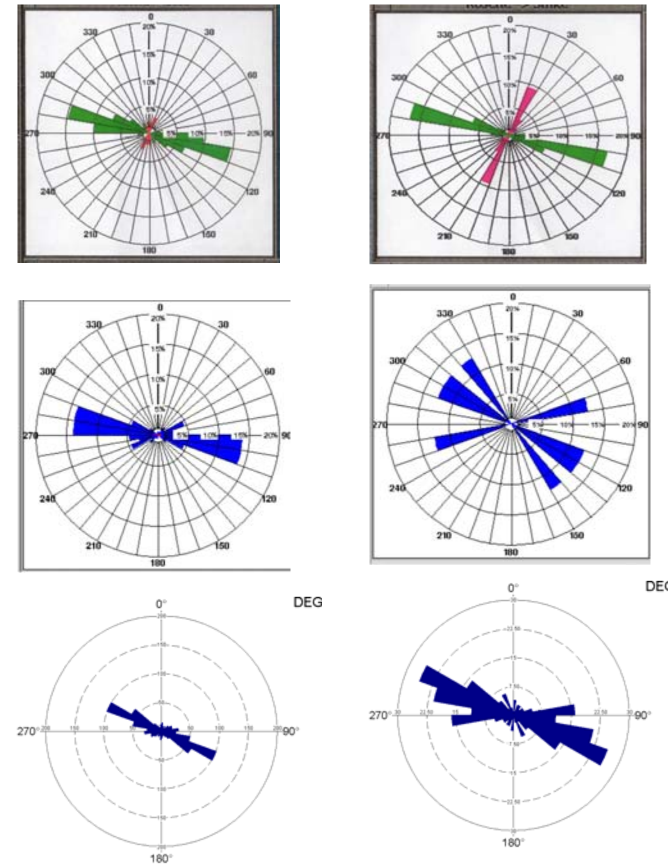
# FMI and Microseismic Results

## Grand Valley



## Rulison



Drilling Induced Fractures

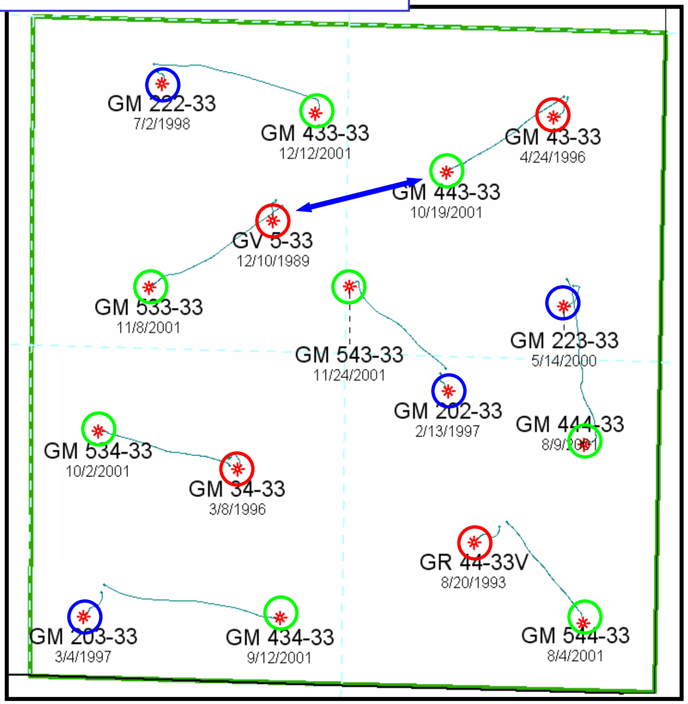
Natural Fractures

Hydraulic Fractures

FMI and Microseismic confirm both hydraulic and natural fracture orientations are approximately the same

# Orientation is Critical

## Grand Valley

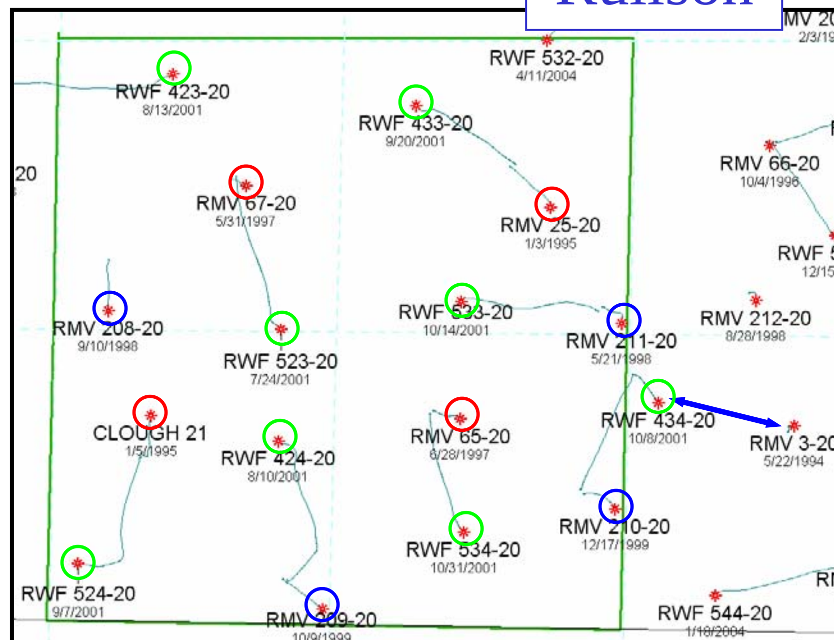



- Two wells in each pilot were on direct fracture orientation to a parent well:

  GM 443-33

  RWF 434-20

## Rulison




- Those 2 wells on exact orientation were poorer performers and measured more depletion
- All other 10-Acre wells (including those as close as 300 feet off orientation) performed at field average

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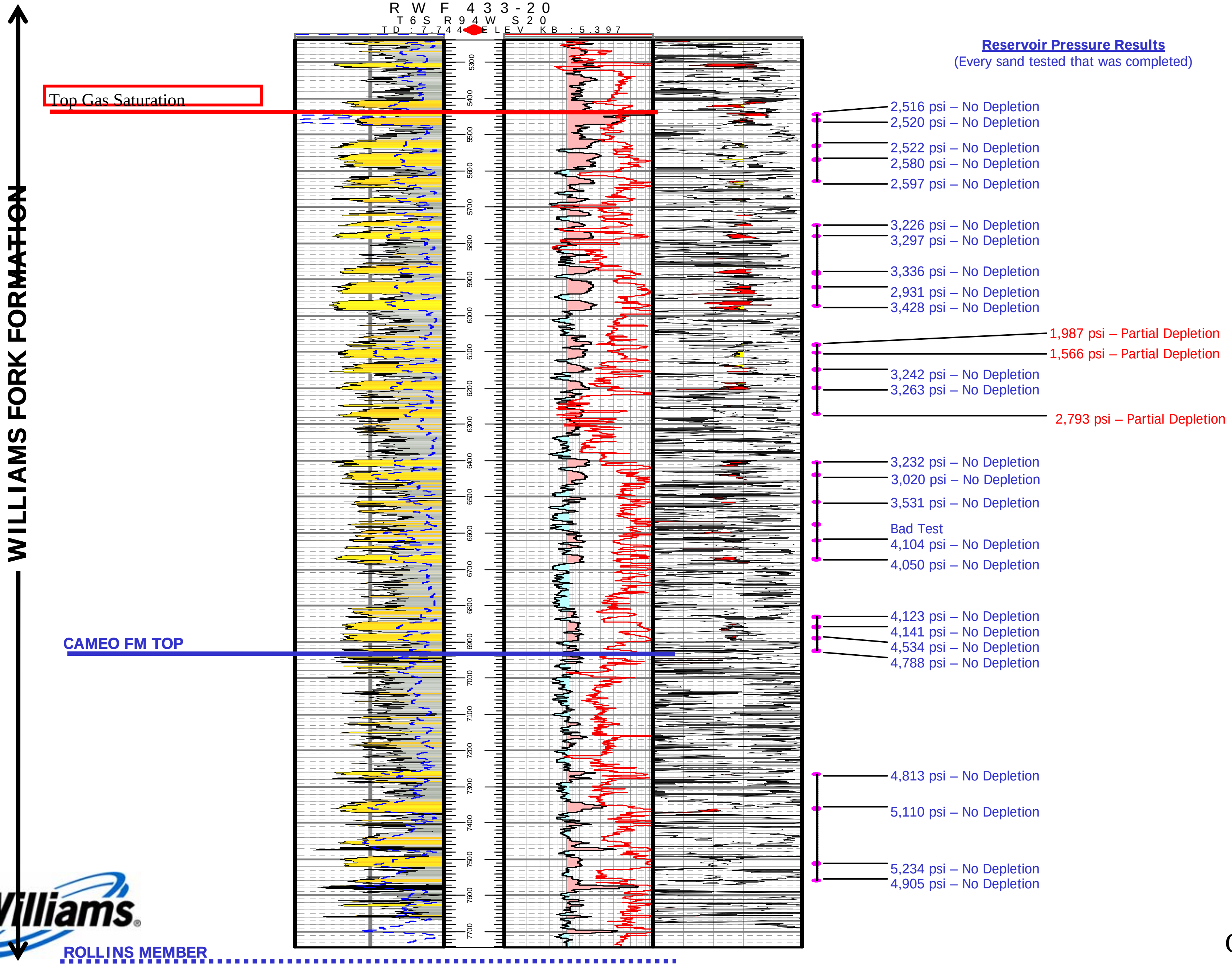
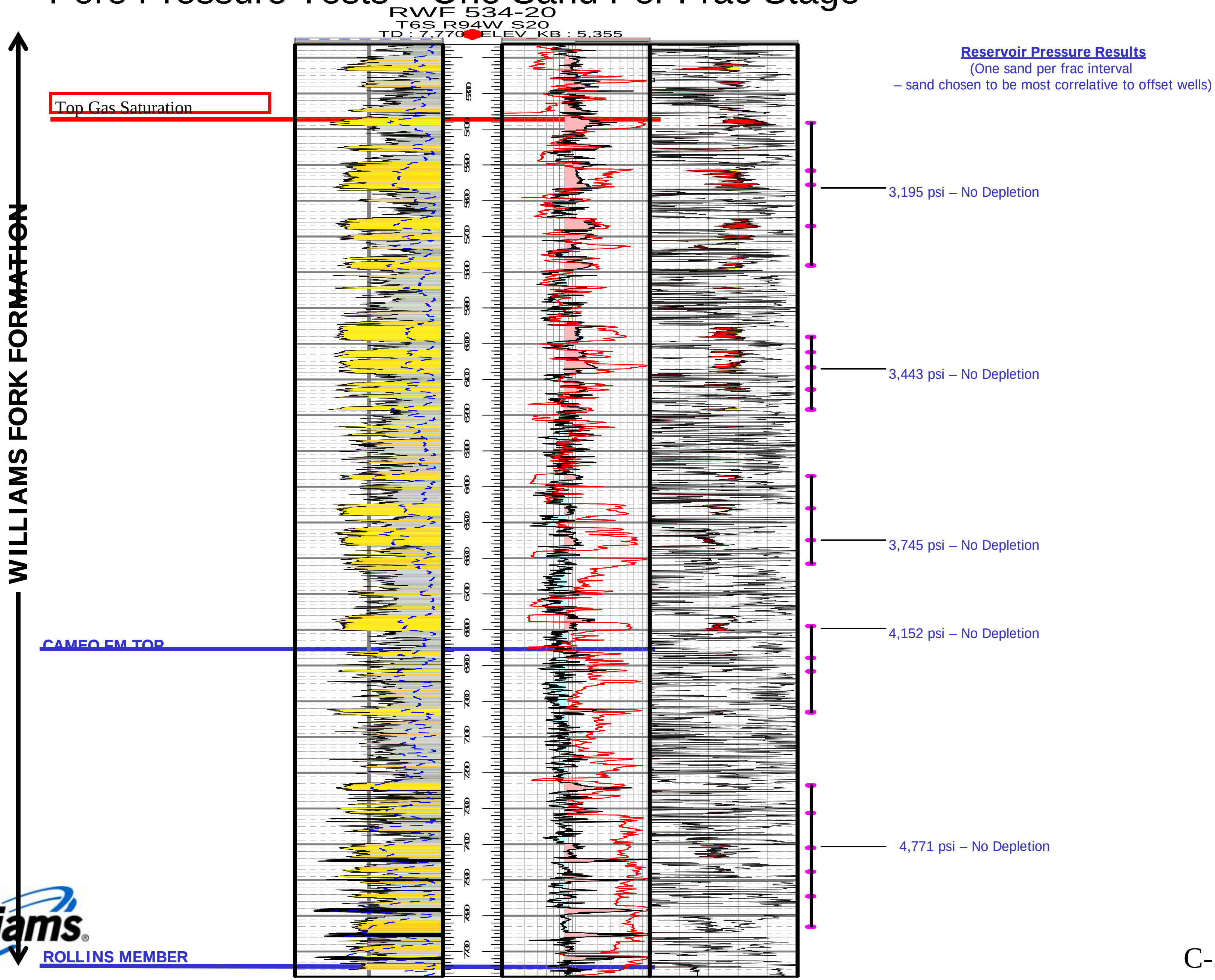
# Pore Pressure Tests – All Sands Completed



# Pore Pressure Tests – One Sand Per Frac Stage



# Grand Valley Pressure Testing Summary

| Type of Test | # of Tests Performed | No Depletion Results | Partially Depleted Results |
|---|---|---|---|
| 40-acre Pilot Pressure Tests | **6** | **6** 100% | **0** 0% |
| 20-acre Pilot Pressure Tests | **7** | **6** 86% | **1** 14% |
| 10-acre Pilot Total Pressure Tests | **96** | **71** 74% | **25** 26% |
| 10-acre Pilot Pressure Tests (without “Orientation” Well) | **76** | **59** 78% | **17** 22% |

**No Depletion**: Virgin reservoir pressure or slightly less than virgin reservoir pressure
(gas is not being effectively produced from offset wells)

**Partially Depleted**: Less than 85% of virgin reservoir pressure
(gas from some sand bodies is being produced from offset wells)

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# Rulison Pressure Testing Summary

| Type of Test | # of Tests Performed | No Depletion Results | Partially Depleted Results |
|---|---|---|---|
| MWX/M-site Pressure Tests | 7 | 7 100% | 0 0% |
| 20-acre Pilot Pressure Tests | 7 | 7 100% | 0 0% |
| 10-acre Pilot Total Pressure Tests | 125 | 104 83% | 21 17% |
| 10-acre Pilot Pressure Tests (without "Orientation" Well) | 99 | 90 90% | 9 9% |

**No Depletion**: Virgin reservoir pressure or slightly less than virgin reservoir pressure
(gas is not being effectively produced from offset wells)

**Partially Depleted**: Less than 85% of virgin reservoir pressure
(gas from some sand bodies is being produced from offset wells)

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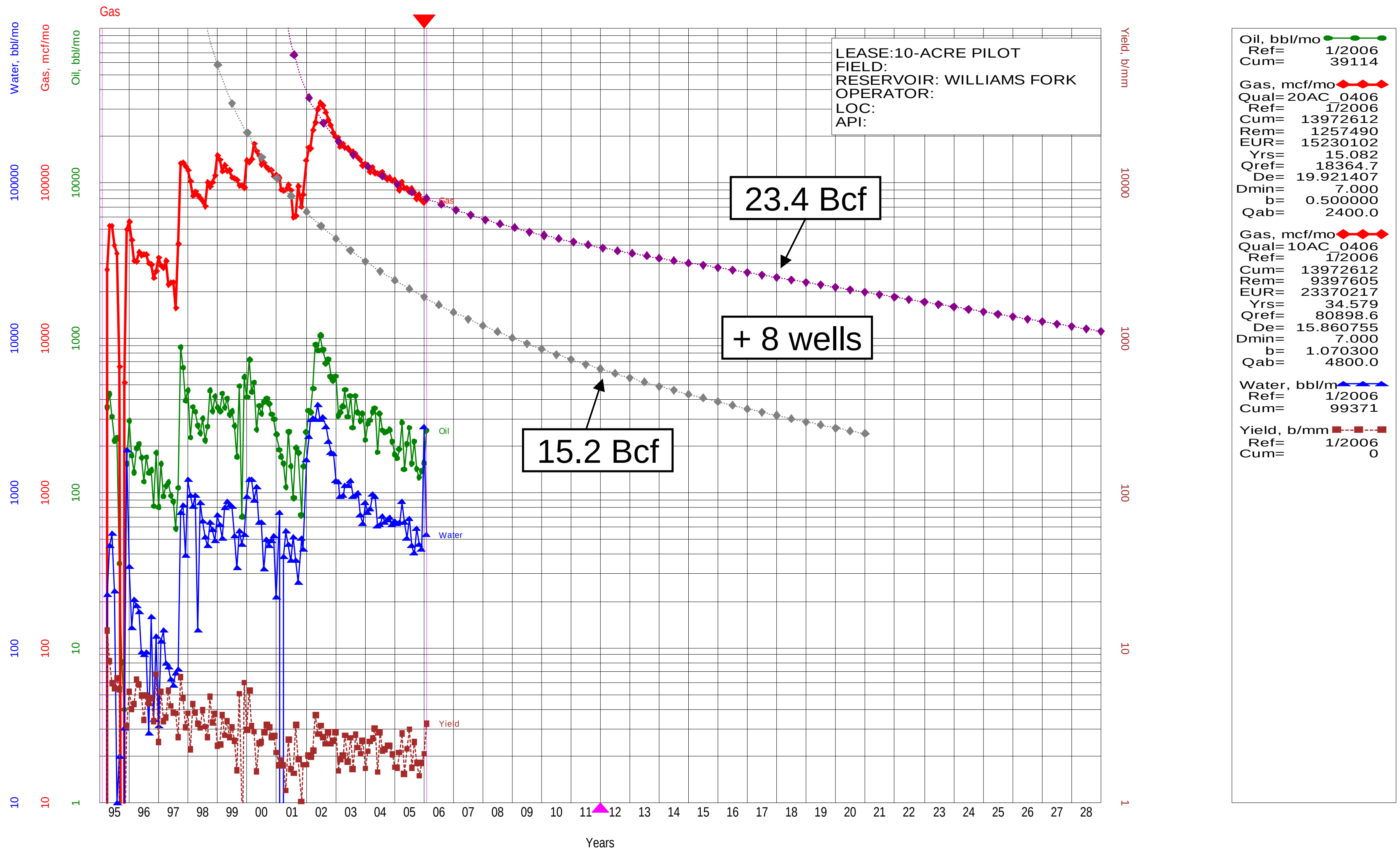
# Pressure Test Summary

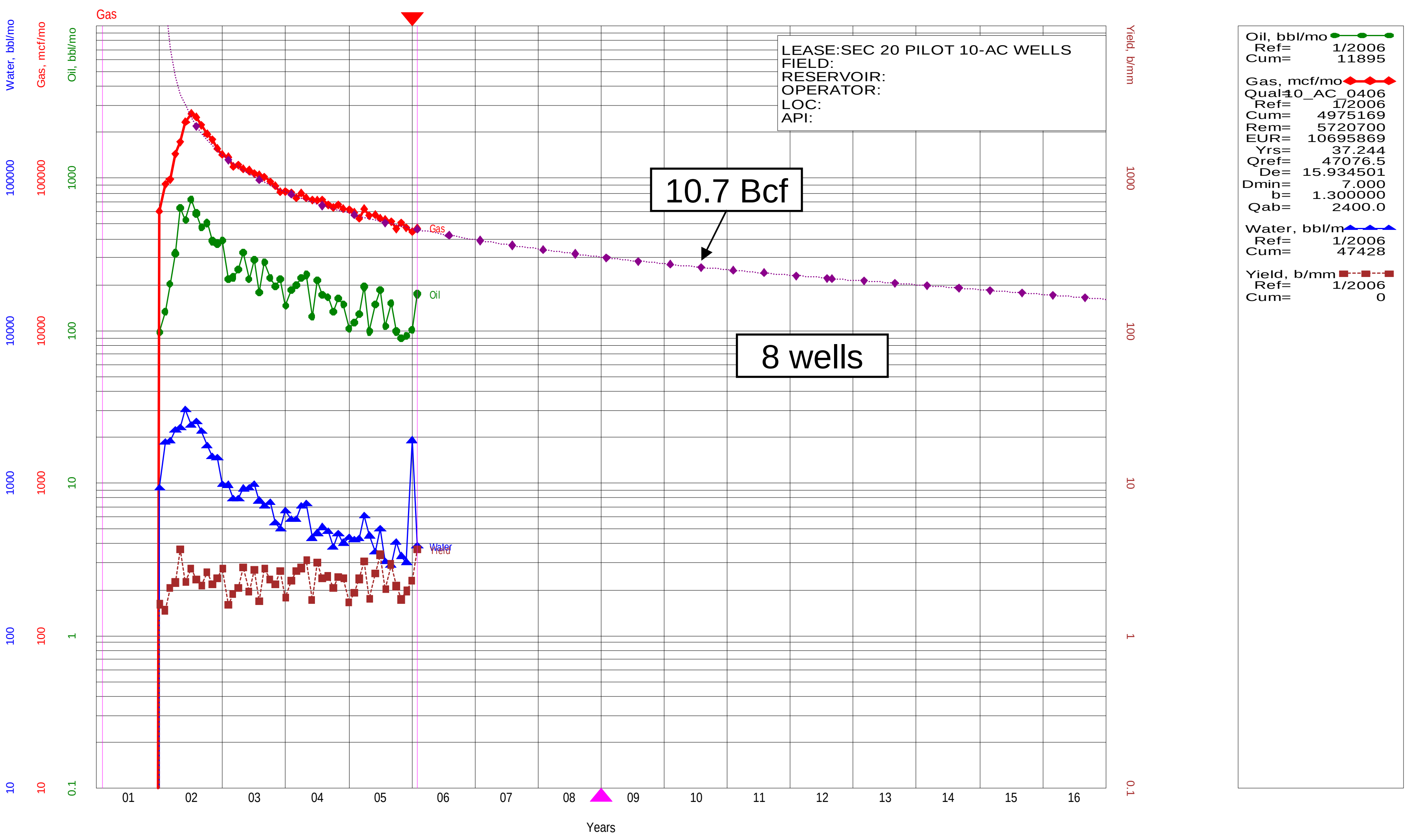
- Minimal amount of depletion measured
- More depletion seen when wells are on exact orientation with old parent wells
- Pressure test results confirm the geologic model
- Even with some pressure reduction, 10-acre density wells will produce substantial incremental gas reserves.

# Rulison 10-Acre Pilot S20-T6S-R94W



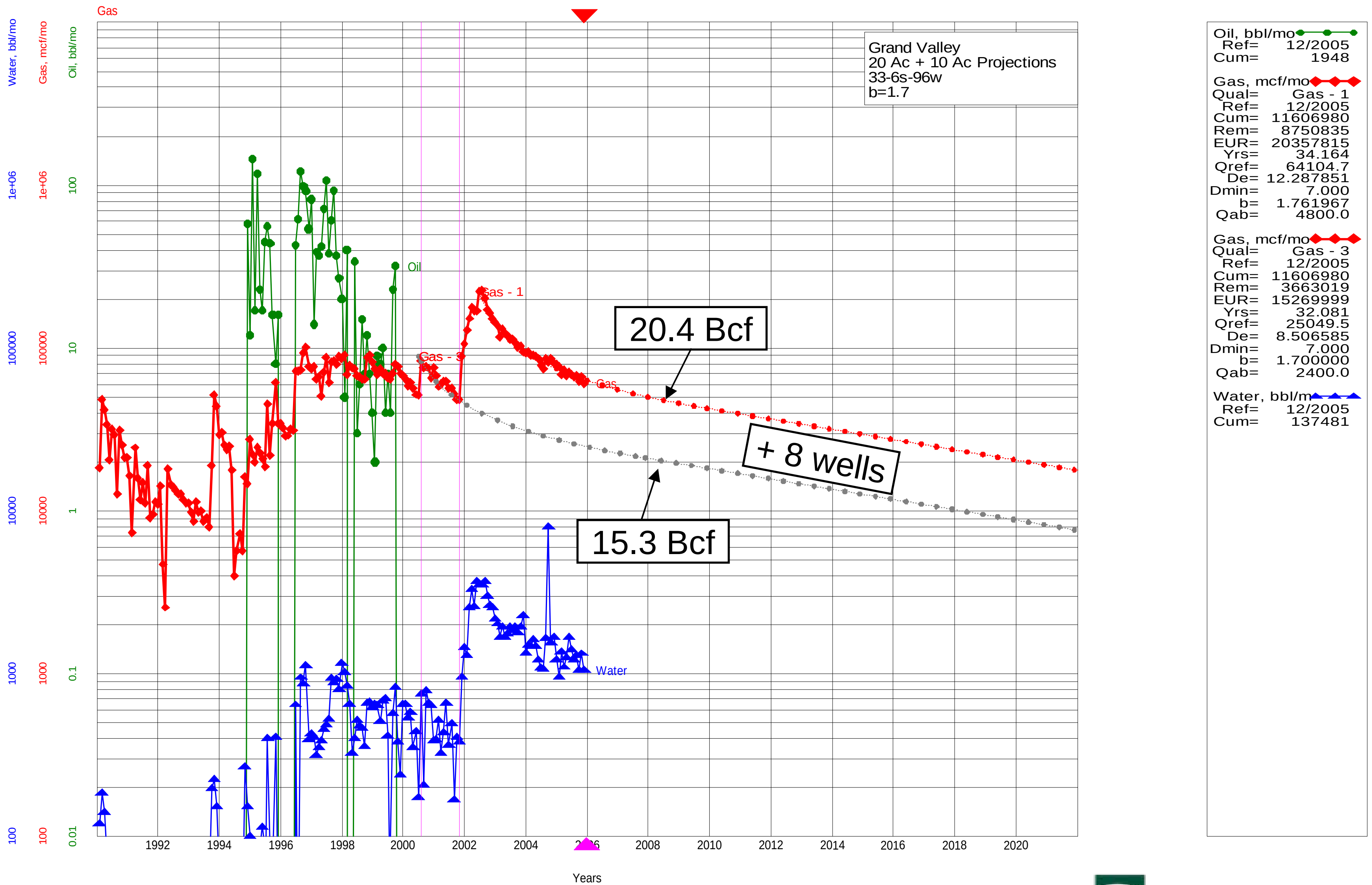

MHA Exhibit 1

# Rulison 10-Acre Pilot S20-T6S-R94W




MHA Exhibit 2

# Grand Valley 10-Acre Pilot S33-T6S-R96W

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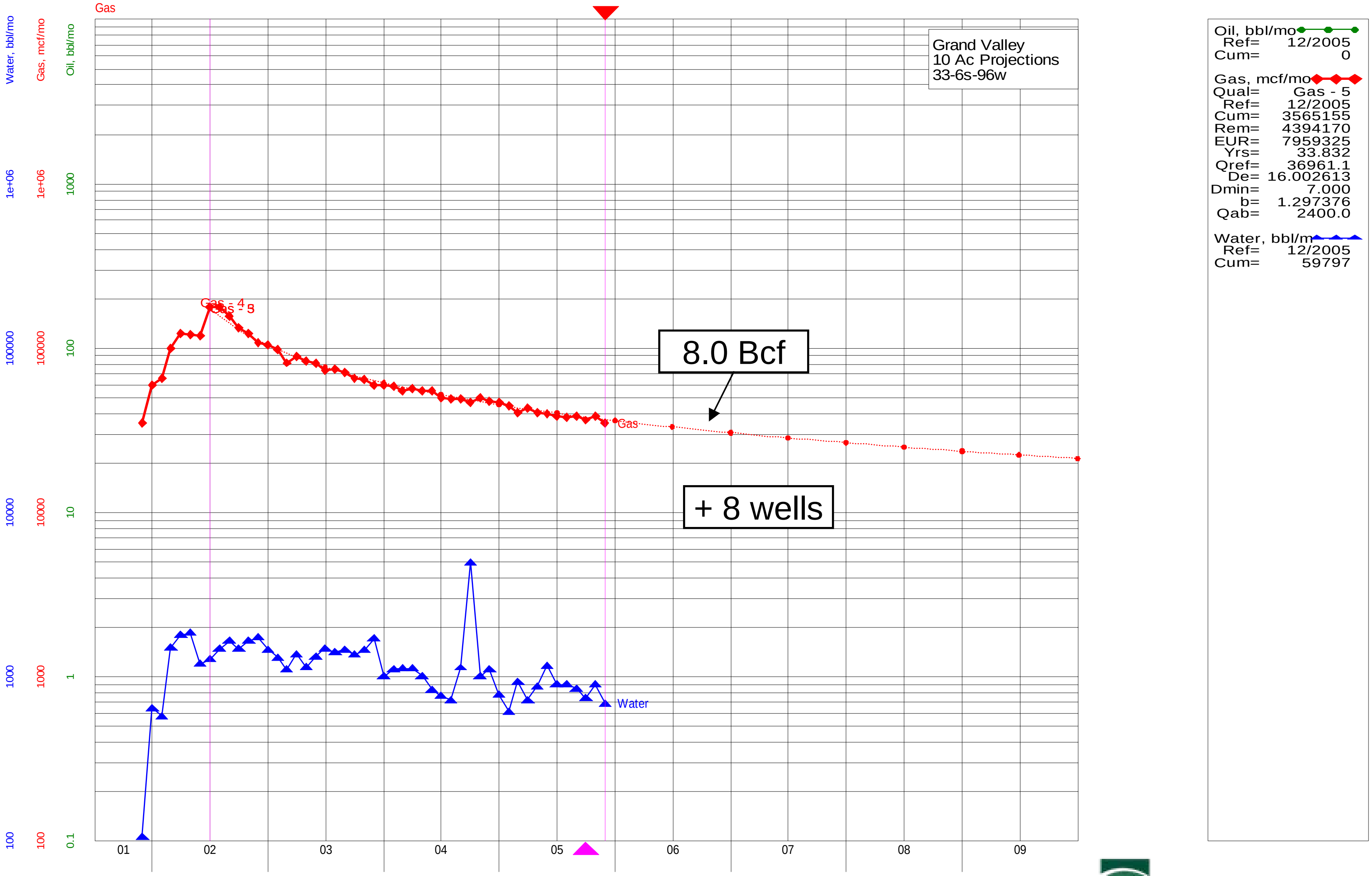
**MHA Exhibit 3**

# Grand Valley 10-Acre Pilot S33-T6S-R96W

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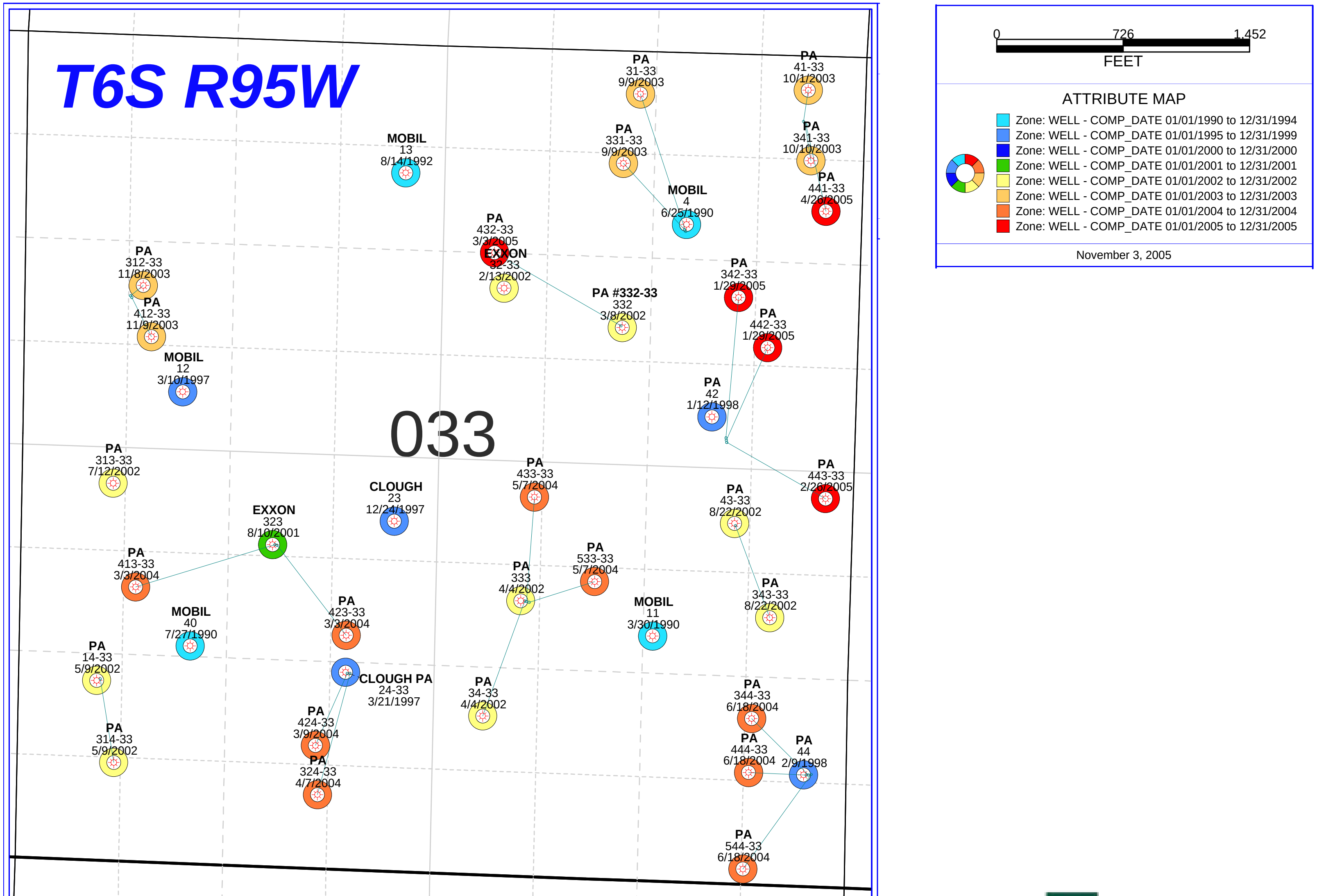
MHA Exhibit 4

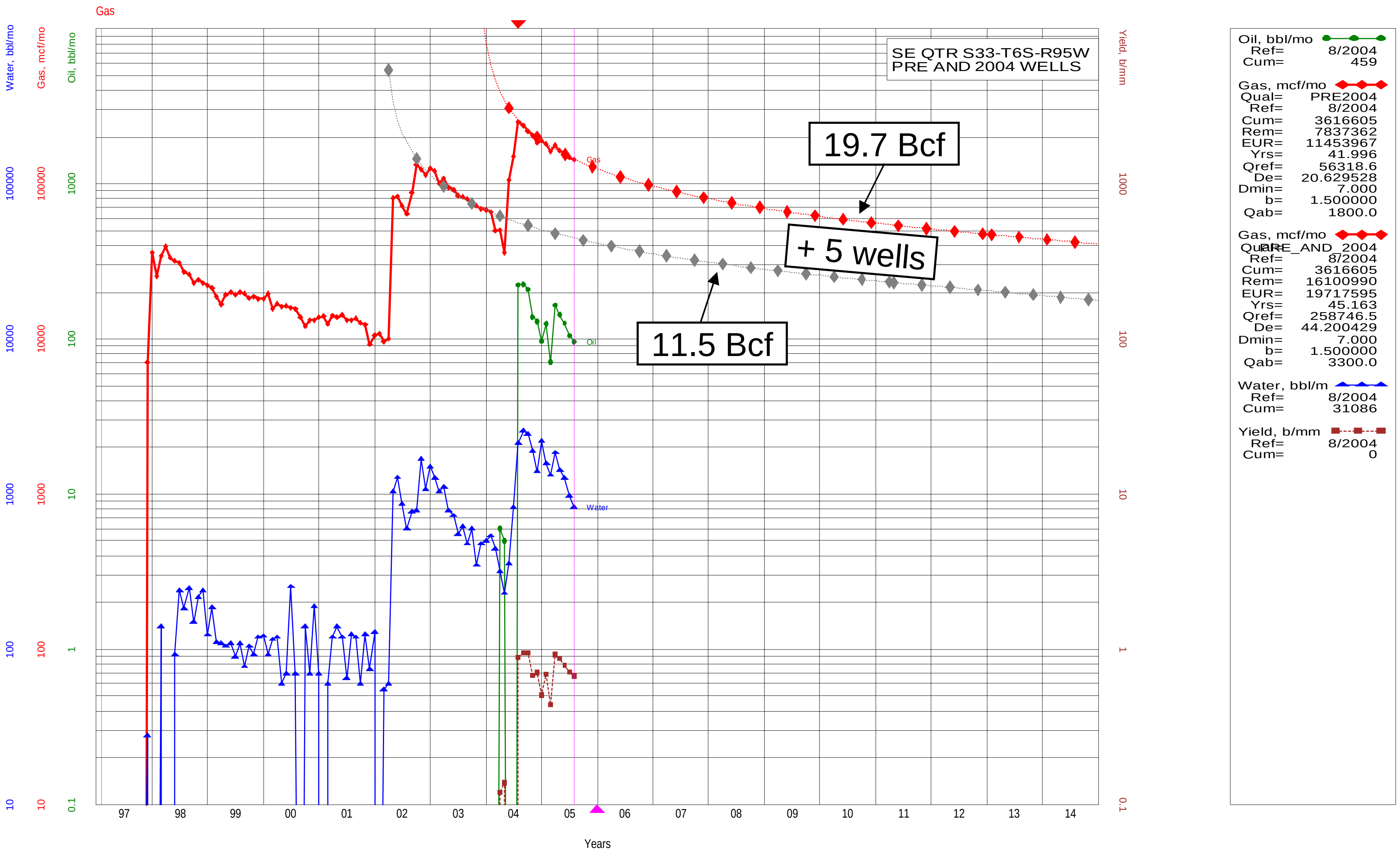
# Parachute Field S33-T6S-R95W




PETRA 11/3/2005 12:00:05 PM

**MHA Exhibit 5**

# Parachute Field SEQtr S33-T6S-R95W

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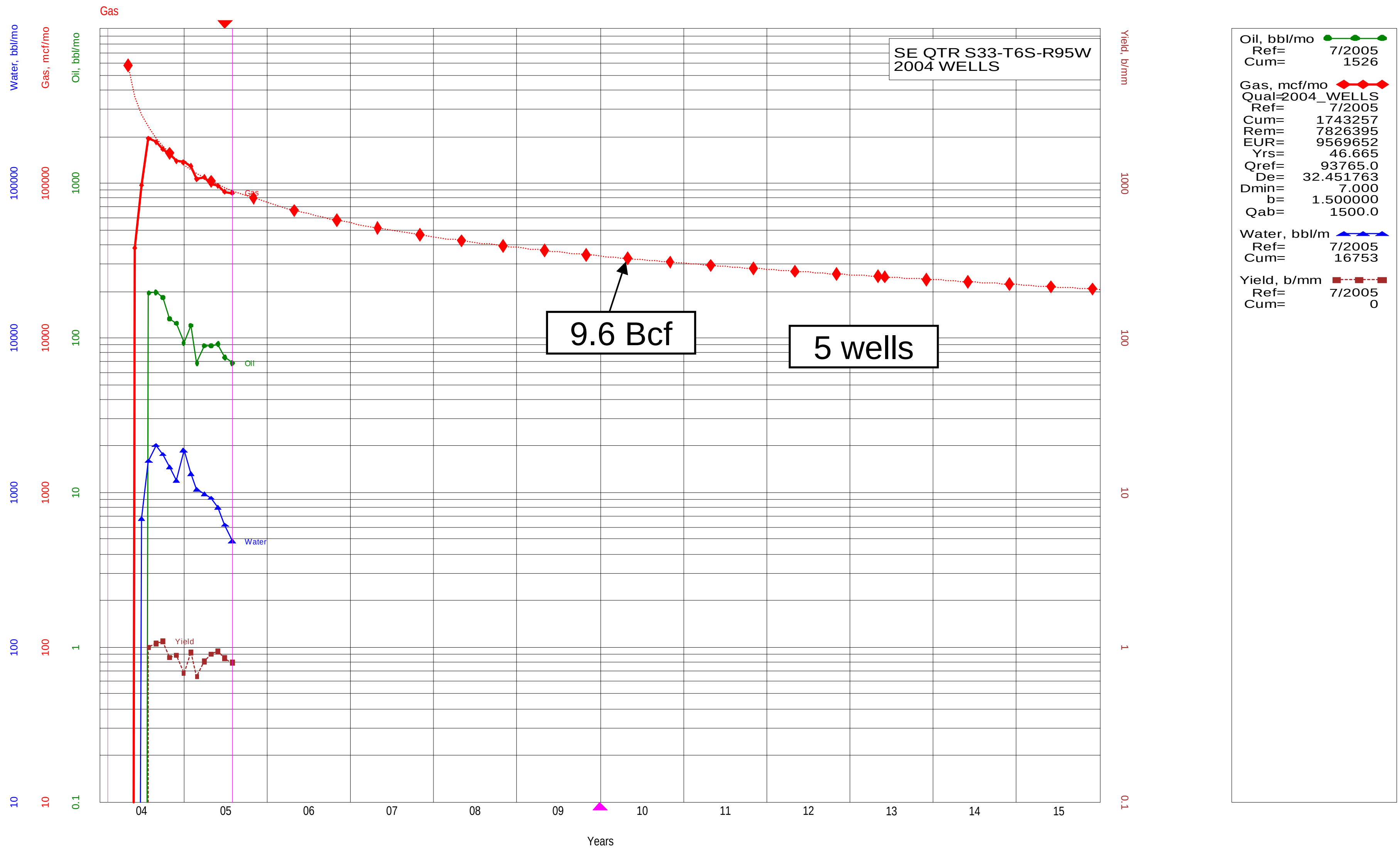
MHA Exhibit 6

# Parachute Field SEQtr S33-T6S-R95W

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MHA Exhibit 7

# Production Decline Analysis
# Williams Fork 10-Acre Density Areas

| | **Rulison S20-T6S-R94W** | **Grand Valley S33-T6S-R96W** | **Parachute S33-T6S-R95W** |
|---|---|---|---|
| Estimated Ultimate Recovery With 20-Acre Spacing, Bcf | 15.23 | 15.27 | 11.45 |
| Estimated Ultimate Recovery With 10-Acre Spacing, Bcf | 23.37 | 20.36 | 19.72 |
| Increase in Estimated Ultimate Recovery, Bcf | 8.14 | 5.09 | 8.27 |
| Estimated Ultimate Production From10-Acre Wellbores, Bcf | 10.7 | 7.92 | 9.57 |
| Percentage of 10-Acre Well Production Representing New Reserves | 76.1% | 64.3% | 86.4% |

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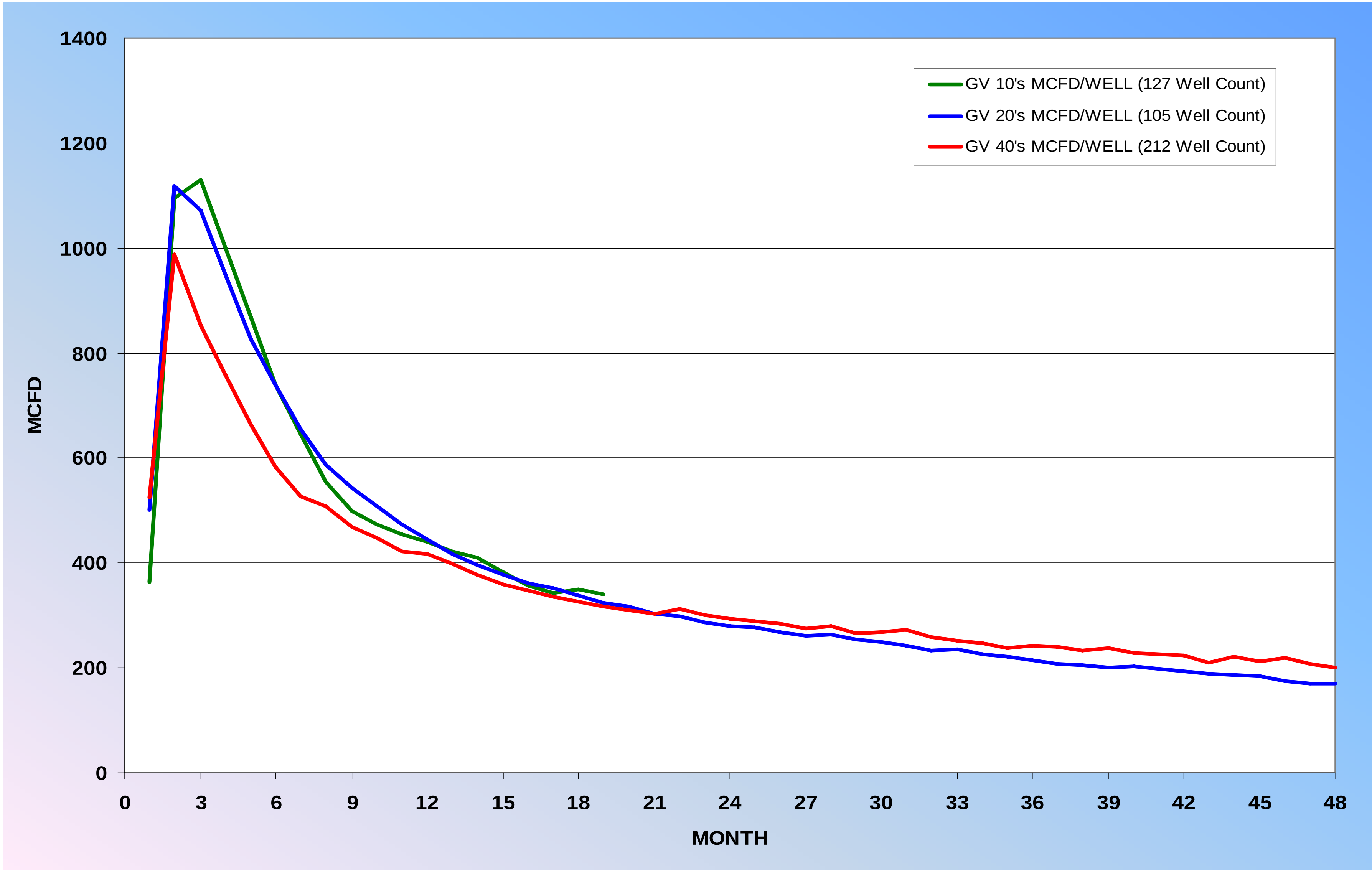
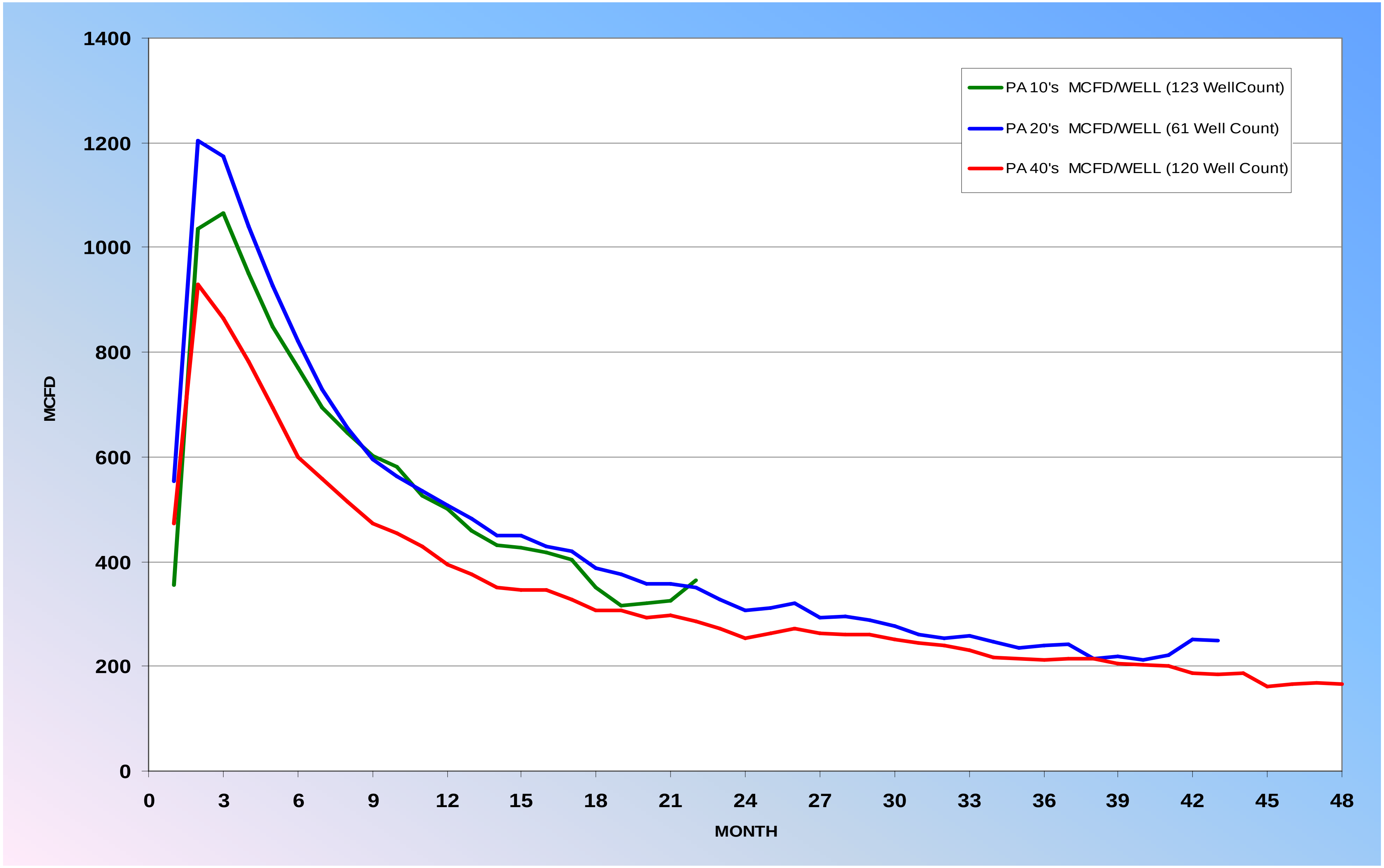
MHA Exhibit 8

# Grand Valley Field Average Monthly Production Comparison



# Parachute Field Average Monthly Production Comparison

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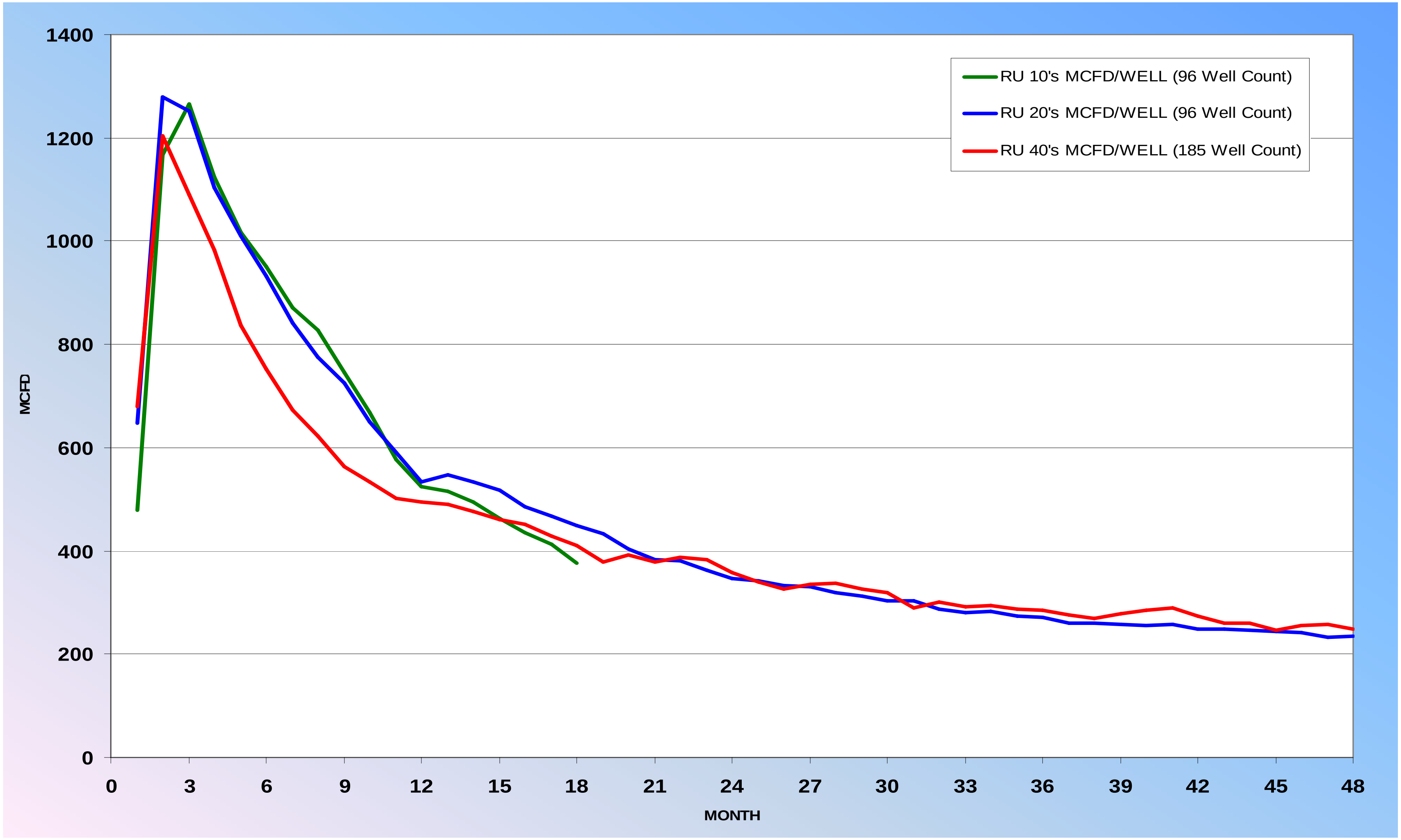
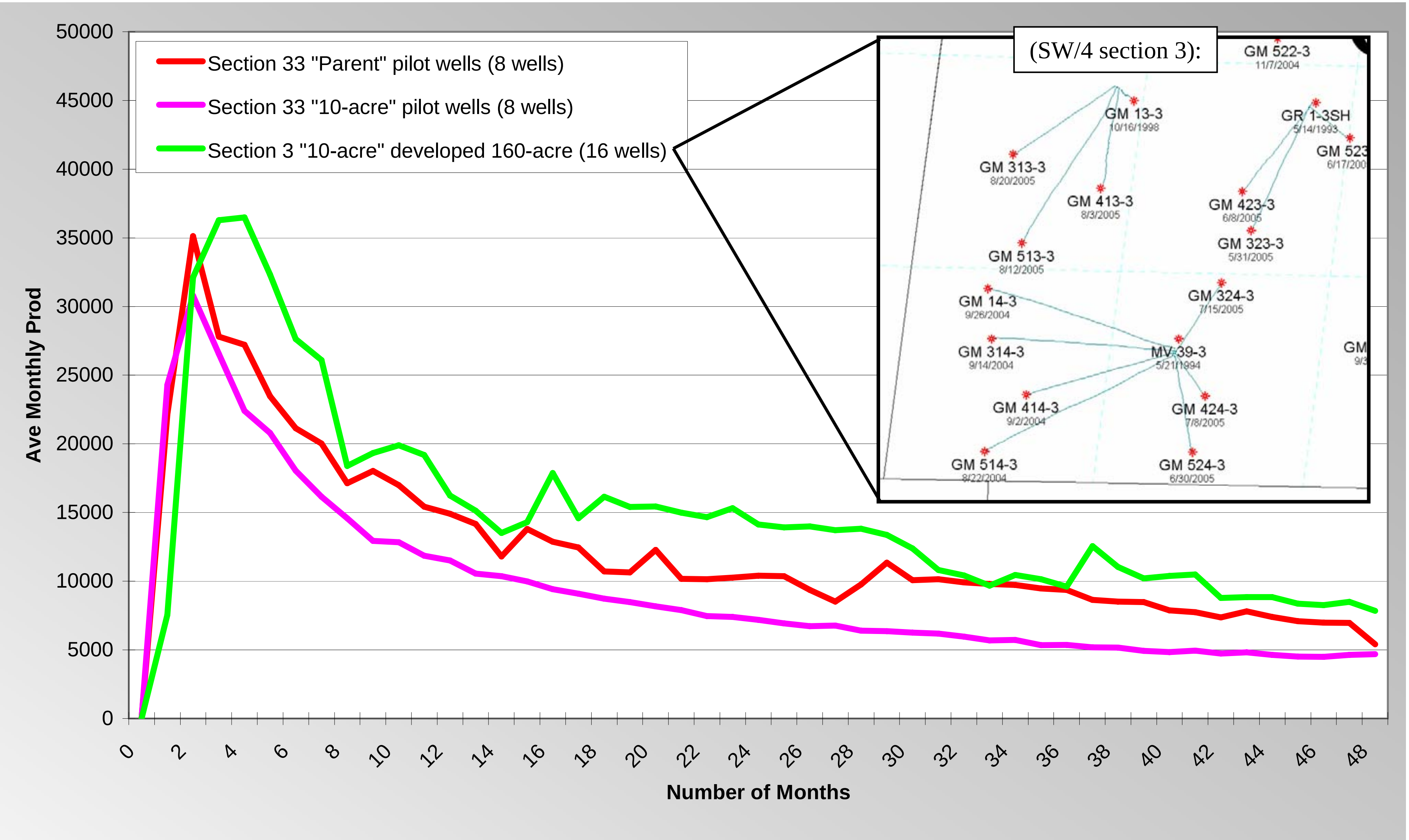
# Rulison Field Average Monthly Production Comparison



# Adjacent 160-acre in Grand Valley Field

## Average Monthly Production with "Optimal" Well Placement



# Summary of Gas-In-Place Estimates and Recoverable Gas Estimates

## GAS IN PLACE PER 640 ACRES-WILLIAMS FORK

| | | |
|---|---|---|
| USGS 1987 Report | 110.9 BCF | Independent Research Reports |
| MWX Project - Rulison | 120.9 BCF | |
| GRI 1999 Report | 70 – 170 BCF | |

Barrett 1995 GIP Analysis 87.0 BCF Grand Valley/Parachute
Barrett 93 Well Survey 122.0 BCF Rulison

Grand Valley 2002 Williams Analysis 105.0 BCF
Parachute 2002 Williams Analysis 120.0 BCF
Rulison 2002 Williams Analysis 135.0 BCF

## RECOVERY FACTORS AT DIFFERENT WELL DENSITIES

| Well Density | Grand Valley @ 1.20 BCF/Well | Parachute @ 1.35 BCF/Well | Rulison @ 1.55 BCF/Well |
|---|---|---|---|
| 640 Acres | 1% | 1% | 1% |
| 320 Acres | 2% | 2% | 2% |
| 160 Acres | 5% | 5% | 5% |
| 80 Acres | 9% | 9% | 9% |
| 40 Acres | 18% | 18% | 18% |
| 20 Acres | 37% | 36% | 37% |
| **10 Acres*** | **73%** | **72%** | **73%** |

* Application Density

Williams

# Benefits of Early 10-acre Density Drilling Approved Development

Drilling

- Take advantage of one rig move to a location to develop 10-acre wells within reach. Less $$'s for rig moves and re-disturbance of pads.
- Lessening the likelihood for well problems during drilling operations; stuck pipe, sidetracking, well control issues due to possible pressure variations between individual sand bodies.

Completions

- Increase the fracture stimulation effectiveness of all targeted pay sands which can be compromised if differing pressured sands are encountered during completions.
- Cost effective to complete multiple wells on one pad at the same time.

# Benefits of Early 10-acre Density Drilling Approved Development (cont.)

Reservoir

- Ability to optimally place bottom hole locations that will in turn minimize well interference and maximize ultimate recovery of gas-in-place.

Community

- Lessens the assured return and re-disturbance of a well pad over and over for 40, 20, and 10-acre development.
- Would lessen operational time per well location and reduce prolonged road traffic.

# Engineering Summary

- Pressure testing and production analysis confirms geological model
- Unique opportunity to analyze an area with staggered time development (40's, 20's, and 10's)
- Bottom hole well placement very important to minimize interference
- Proven new gas recoveries on 10-acre development
- Minimize community impact – one time development