

Rangely Weber Sand Unit Case History (RWSU)



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Chevron North America E&P
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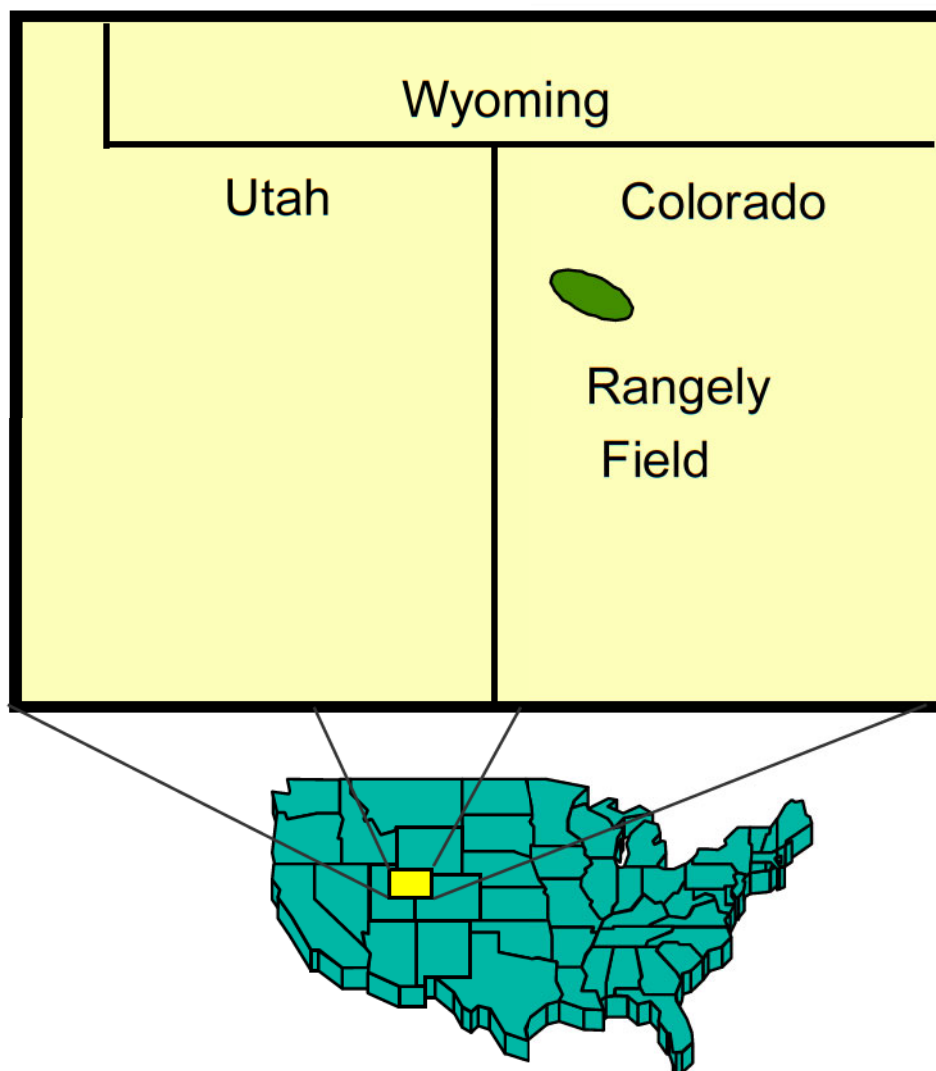




Outline

- **Location**
- **Geology**
- **Field Development History**
- **CO2 Project Development**
- **Recent Efforts**
- **Lessons Learned / Summary**

Rangely Field Location



Rangely Statistics (as of October 2011)



October 2011 monthly numbers	
Oil Production	11,660 B/D
NGL Production	1,247 B/D
Water Production	229,420 B/D
Gas Production	157 MMCF/D*
CO ₂ Purchases	31 MMCF/D
*All produced gas is re-injected.	

Cumulative as of October 2011	
Oil Production	887 MMB
NGL Production	11.8 MMB
Water Production	4.5 BB
CO ₂ Purchase	540 BCF
Gas Production (since CO ₂)	1.1 TCF
CO ₂ Injection	1.6 TCF



Well Data (October, 2011)

Average Elevation	5300 FT
Average Perf Depth	6000 FT
Active Producers	372
189 Electric Submersible Pumps	
69 Flowing Wells	
90 Rod Pumps	
Active Injectors	267
Total Wells*	947
*including P&A and SI	



RWSU - Geology





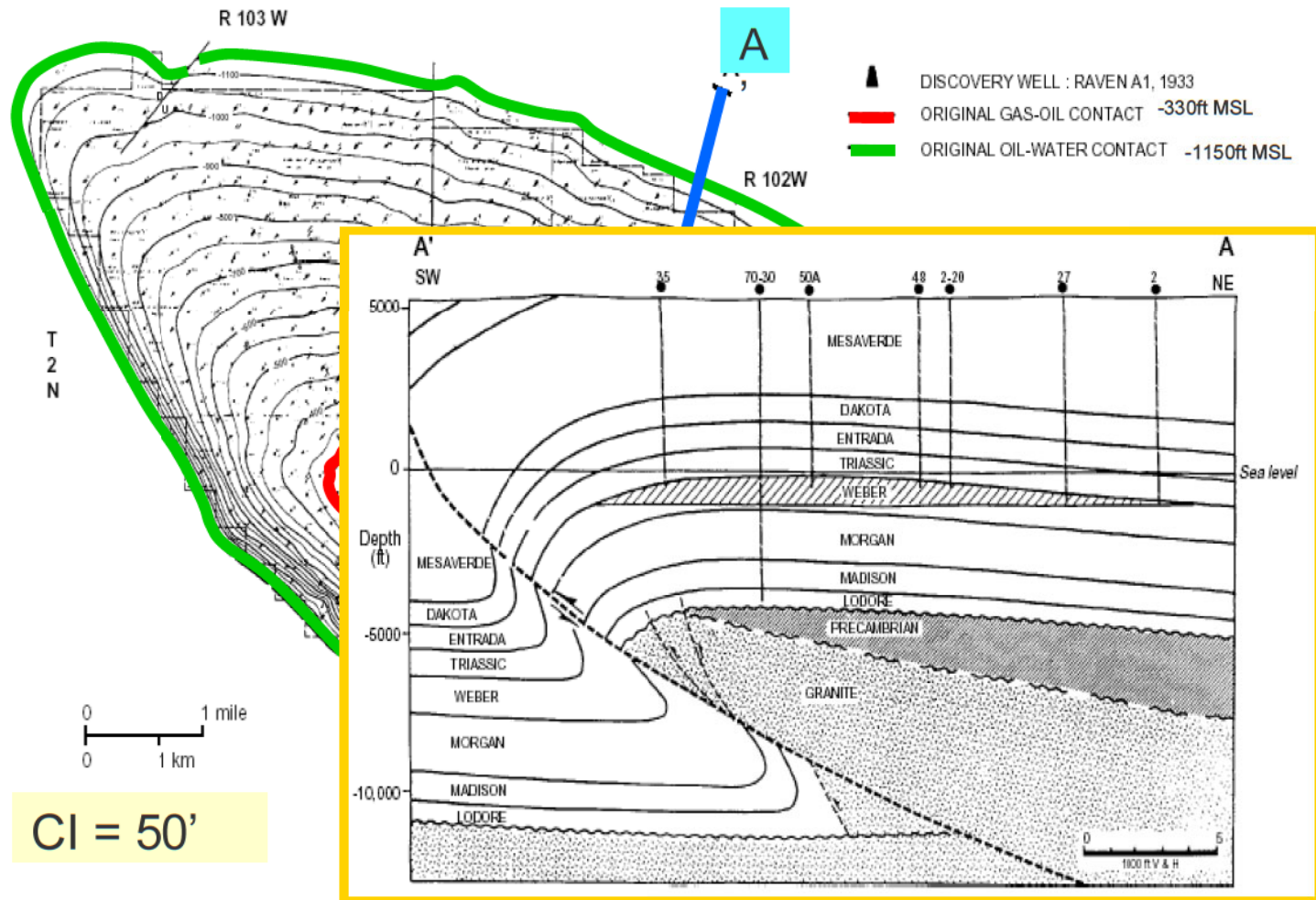
Reservoir Properties

Producing Horizon	Weber
Lithology	Aeolian SS w/fluvial stringers
Unit Area	19,153 Acres
Average Gross Thickness	526 FT
Average Effective Thickness	189 FT
Average Effective Porosity	12%
Average Effective Perm.	8 md
Average Initial Swi	35.8%
Reservoir Temperature	160 deg. F
Initial Reservoir Pressure	2750 psi
Fractures	Some faulting & natural fractures

Rangely Field Top Weber Structural Contour Map



Top Weber Ss structure map of the Rangely Field (Mendeck, 1986)



Rangely Type Log



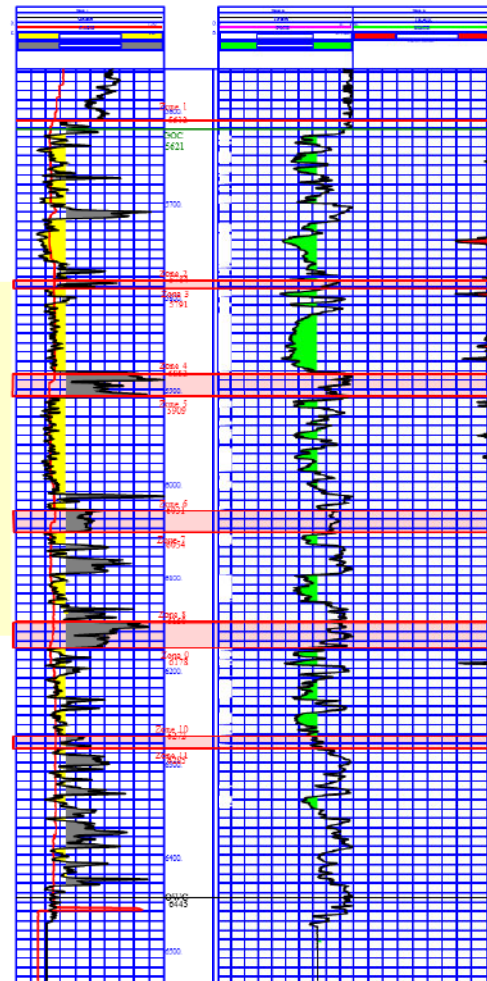
TYPE WEBER LOG
RANGELY FIELD
U.P. 139Y-28

Odd Zones = Aolian

PAY

Even Zones = Fluvial

NON-PAY



TOP WEBER

ZONE 1

ZONE 2

ZONE 3

ZONE 4

ZONE 5

ZONE 6

ZONE 7

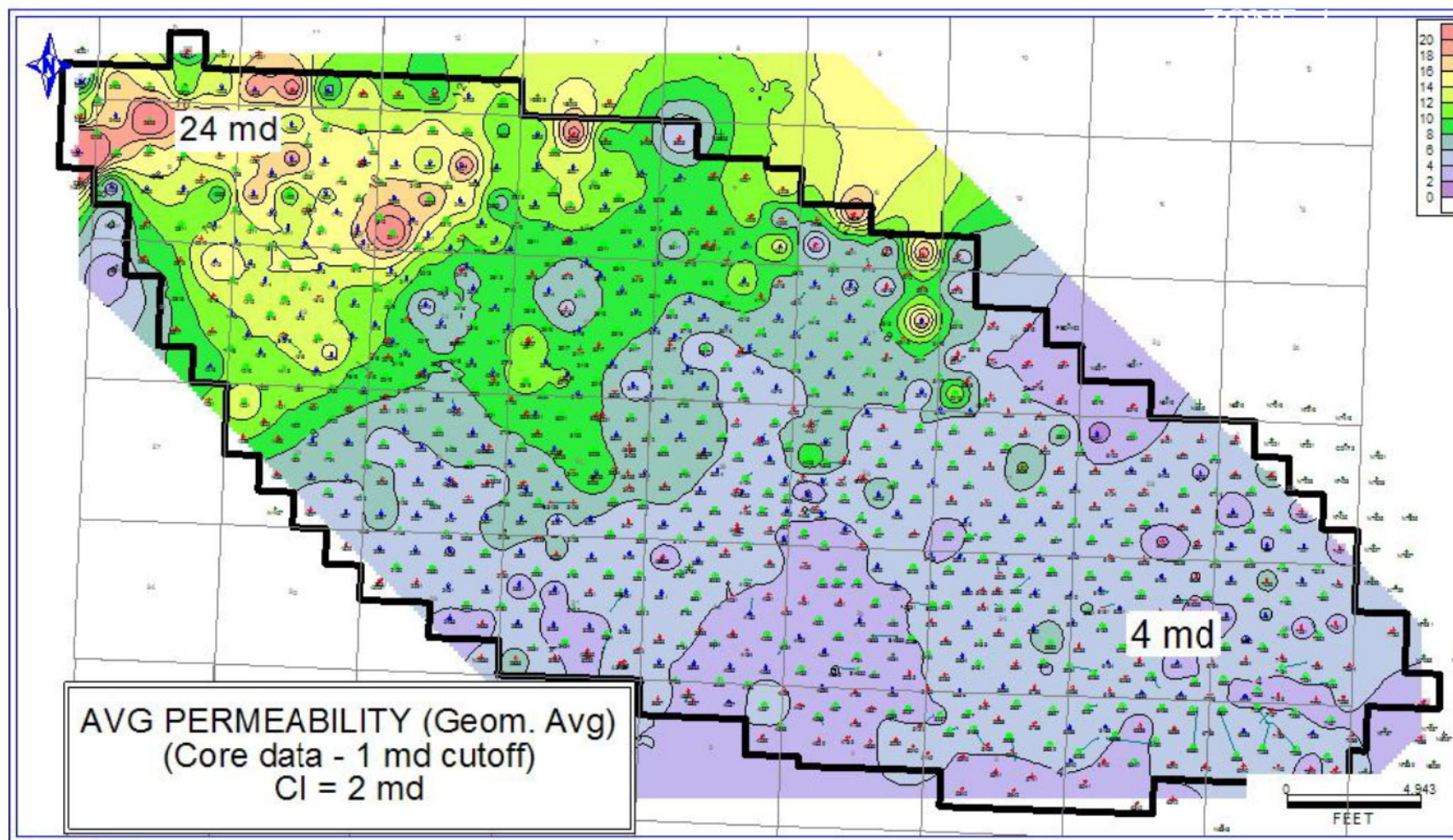
ZONE 8

ZONE 9

ZONE 10

ZONE 11

Rangely Weber Sand Unit





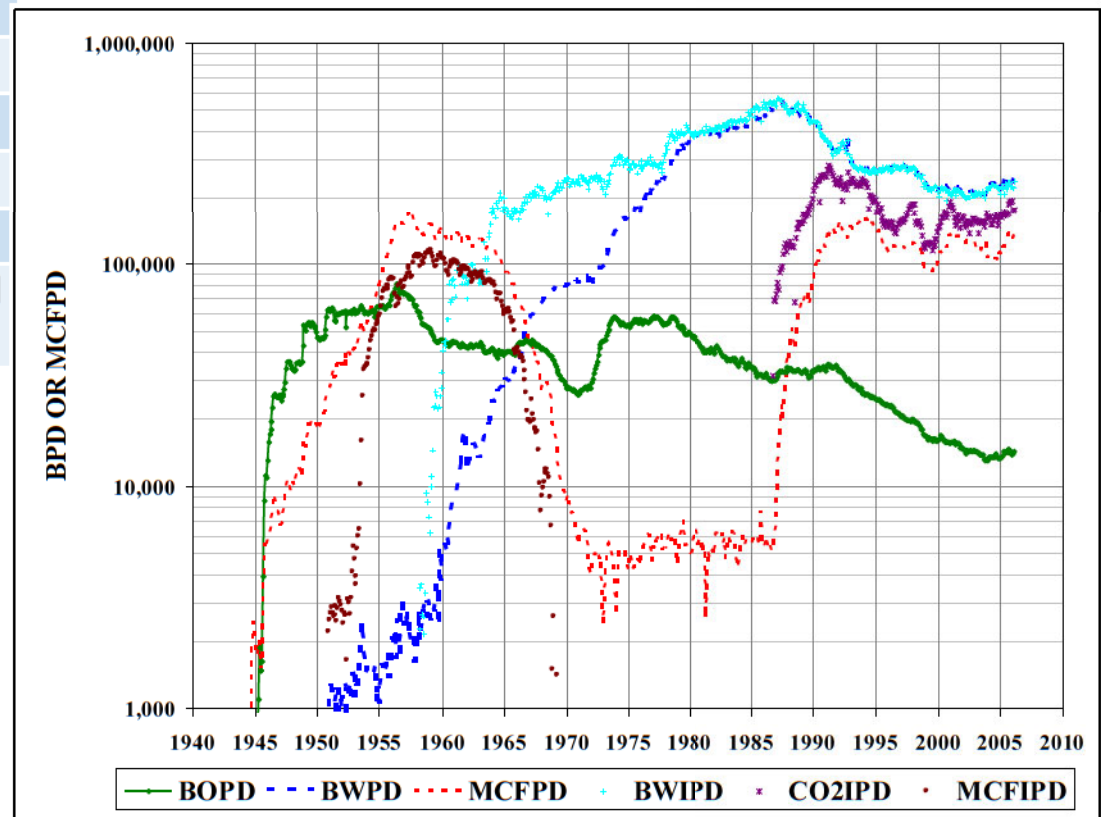
RWSU- Field Development History



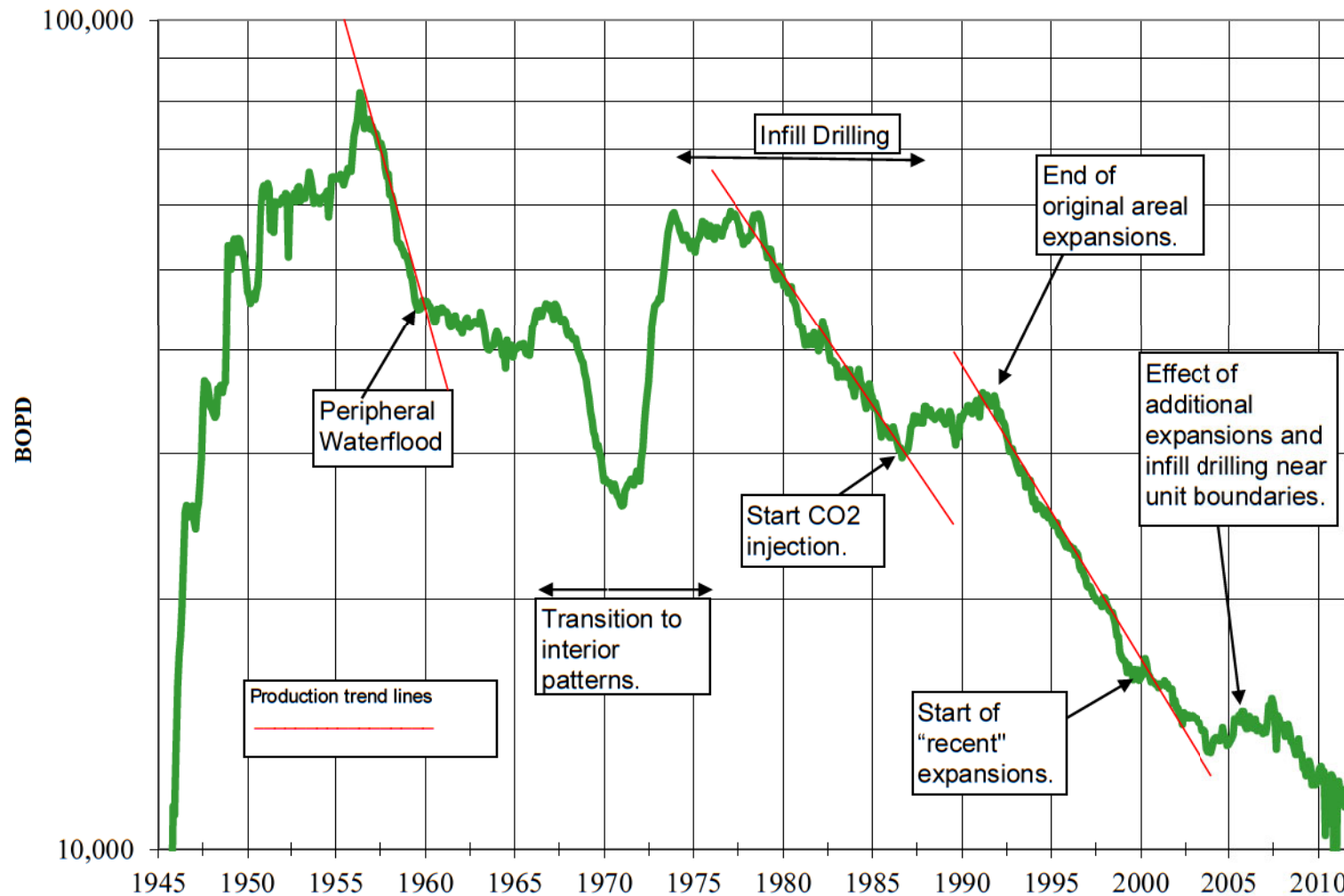
Rangely Weber Sand Unit Development History



1933	Weber Sand Discovery
1944	40 Acre Development
1950-69	HC Gas Injection
1957	Unitization
1958-83	Waterflood Expansions
1963-85	20 Acre Infill, WF Align
1983-present	10 Acre Pilots
1986-	CO2 Flood (tertiary)
2000-2011	Renewed Expansions and Targeted Infill Drilling



RWSU Oil Production History

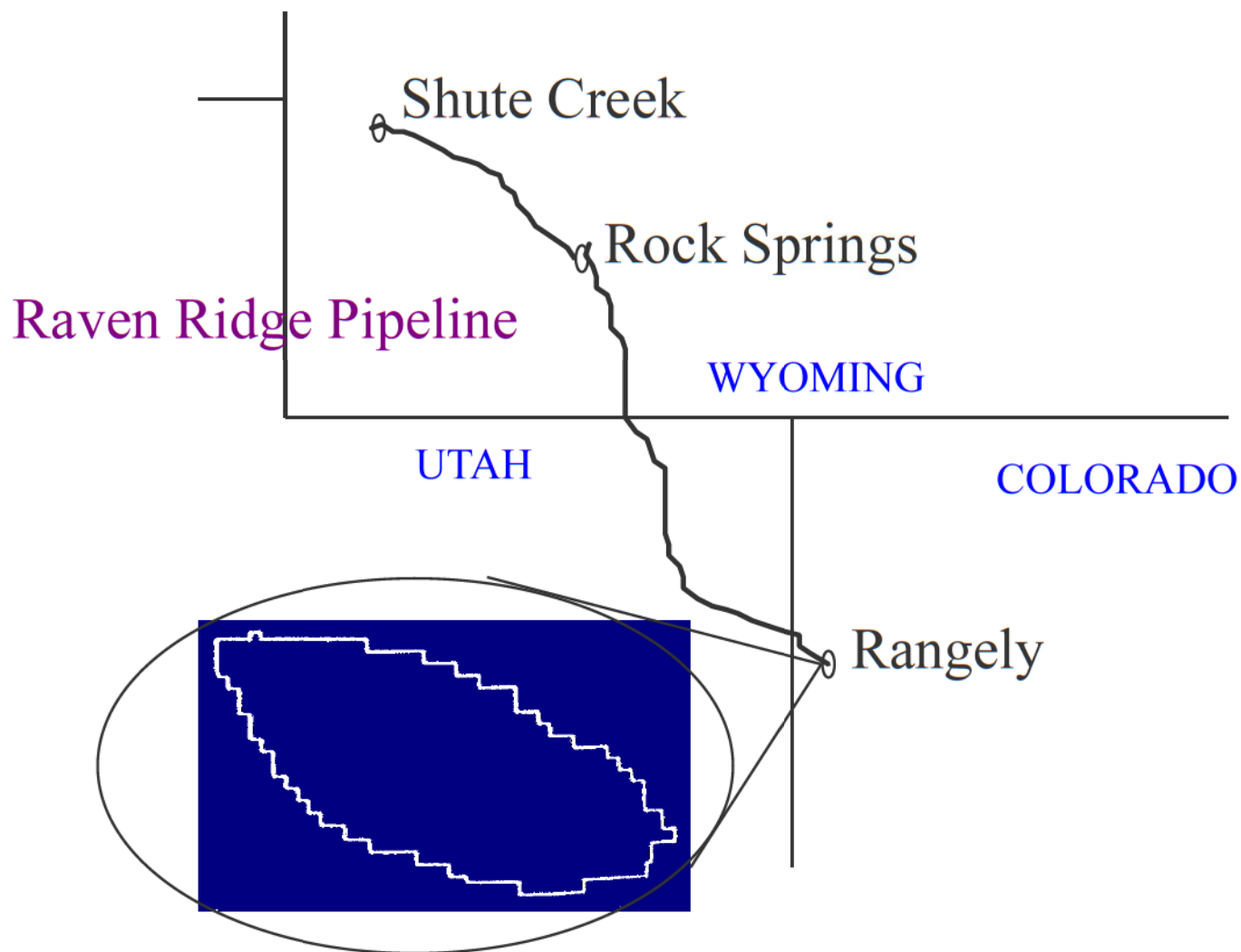




RWSU – CO2 Project Development



Rangely Weber Sand Unit





Initial CO2 Project Design

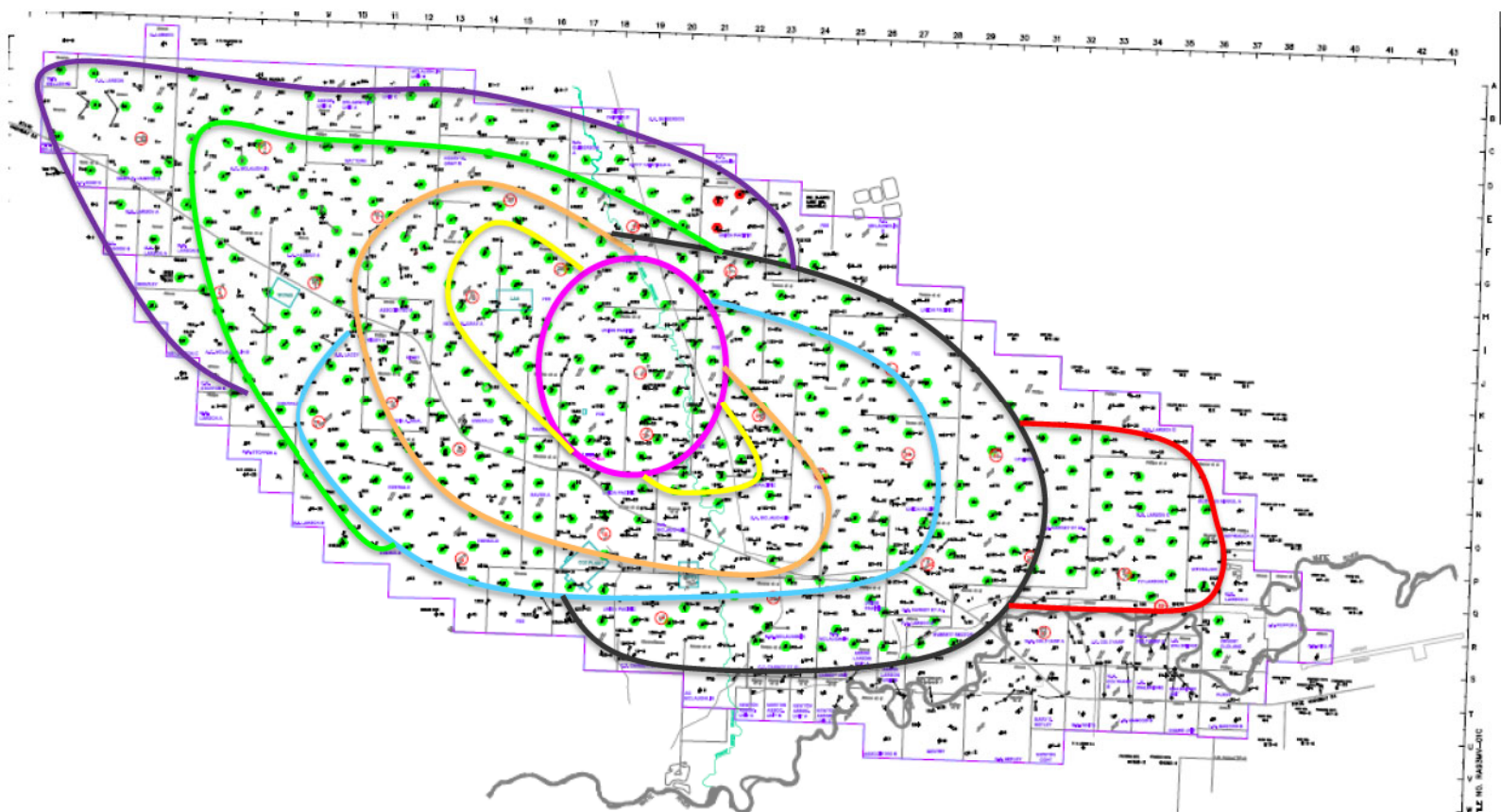
- **1:1 WAG Ratio.**
- **Alternating volumes 1.5% HCPV CO2 and Water.**
- **Inject 30% HCPV CO2 slug.**
- **Follow CO2 with one HCPV water.**
- **106 MMSTB Incremental oil production.**
- **6.7% Incremental oil recovery.**



CO₂ Project Milestones

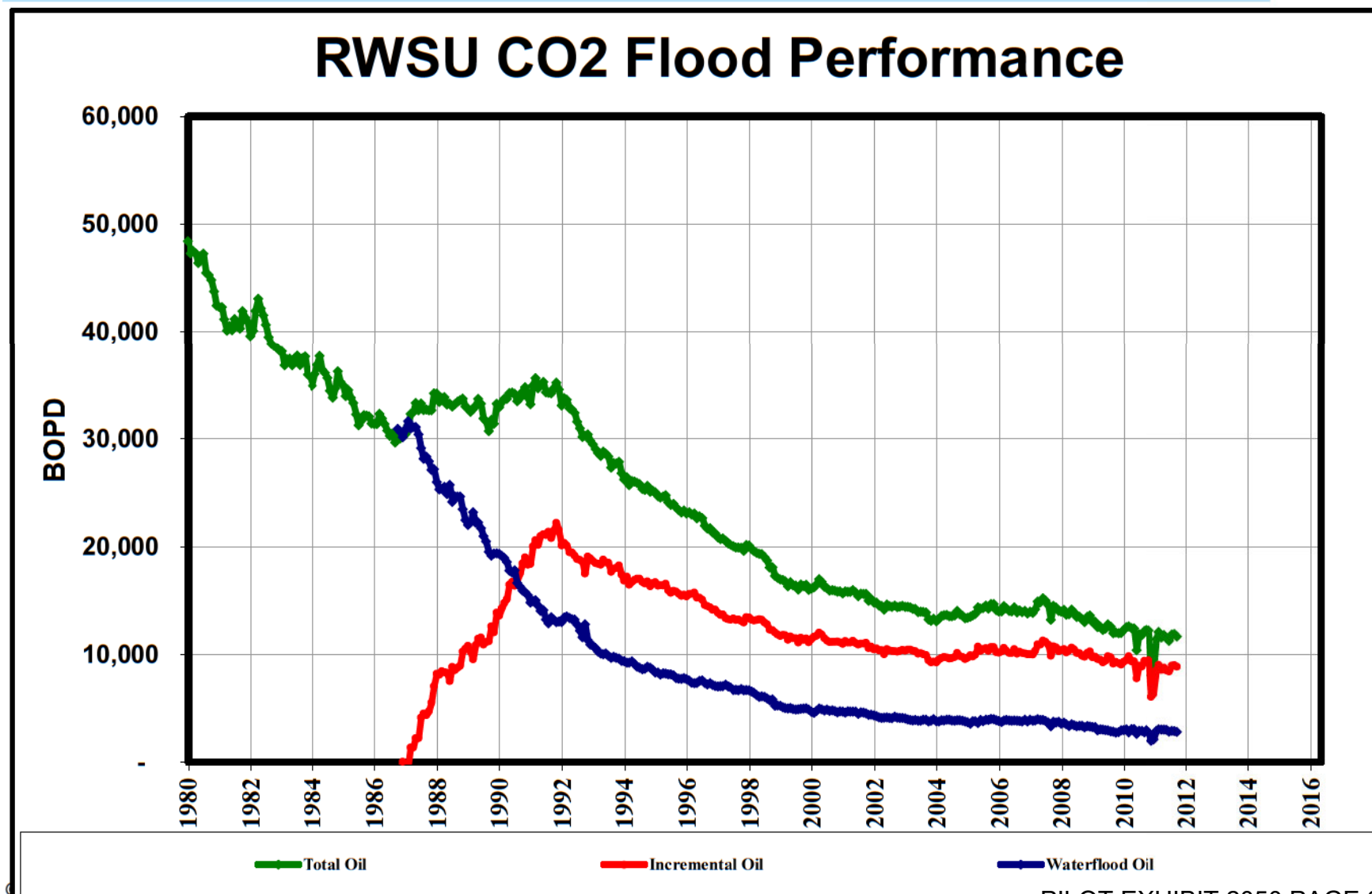
CO₂ project /construction begins.	1985
Raven Ridge Pipeline completed.	1985
CO₂ injection starts.	Oct 1986
Recycle compression and NGL construction.	1987-91
Expansions within original construction area.	1989
Expansion to far east.	1992
Focus on WAG Management, CO₂ highgrading and conformance improvement with some small expansions.	1993-2000
Expansions to the NW and north.	2000-2011

Project Expansion Over Time



Expanded out radially from the original CO2 injection (pink) area.

RWSU CO2 Flood Performance





Major Facilities and Upgrades

- **Recycle compression.**
- **NGL Recovery.**
- **Additional water injection plant.**
- **Collection station re-builds.**
- **New gas distribution system.**
- **New gas gathering system.**
- **Large-scale replacement of production flowlines.**
- **Low-pressure gas gathering system.**



RWSU – Focus Efforts





Focus areas

▪ CO2 Expansions

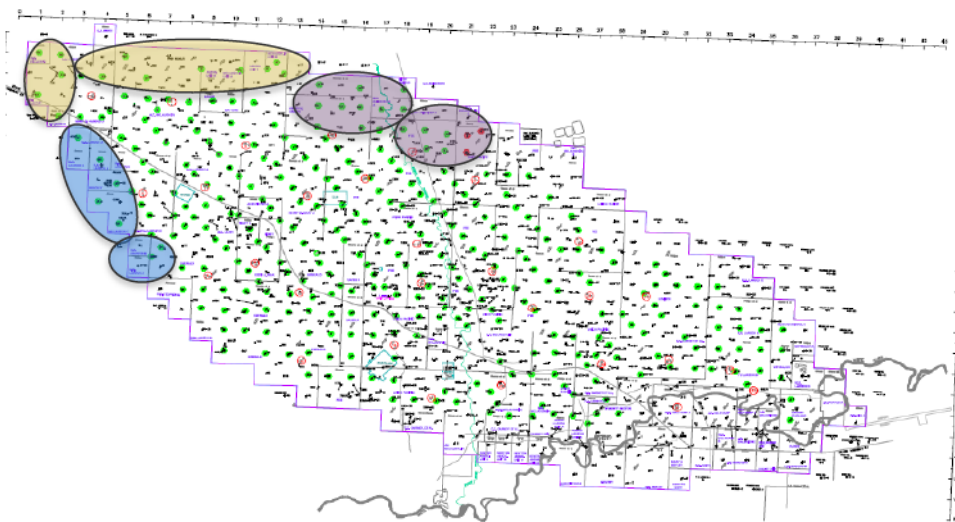
- Expansions have occurred primarily to the west and north areas of the unit.
- There has been significant success.

▪ Infill Drilling

- 20-acre infills to the north and west.
- 10-acre infill pilot.

▪ Base Production

RWSU CO2 Expansions



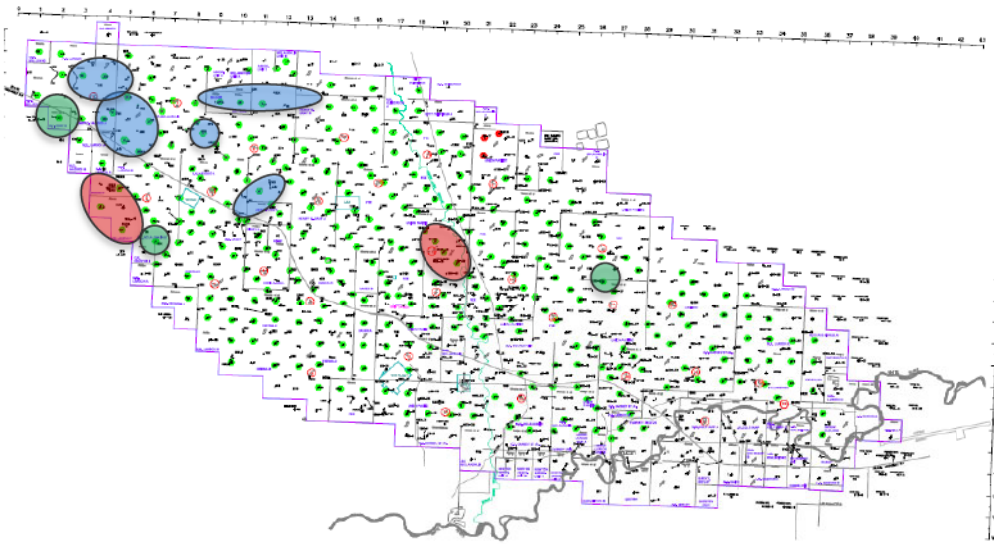
- Expansions have occurred primarily to the west and north areas of the unit.
- These projects contributed approximately 2500 bopd in 2011.
- Cumulative recovery from projects is approximately 3.35MMBO through 2011.
- There has been significant success.

Infill Drilling

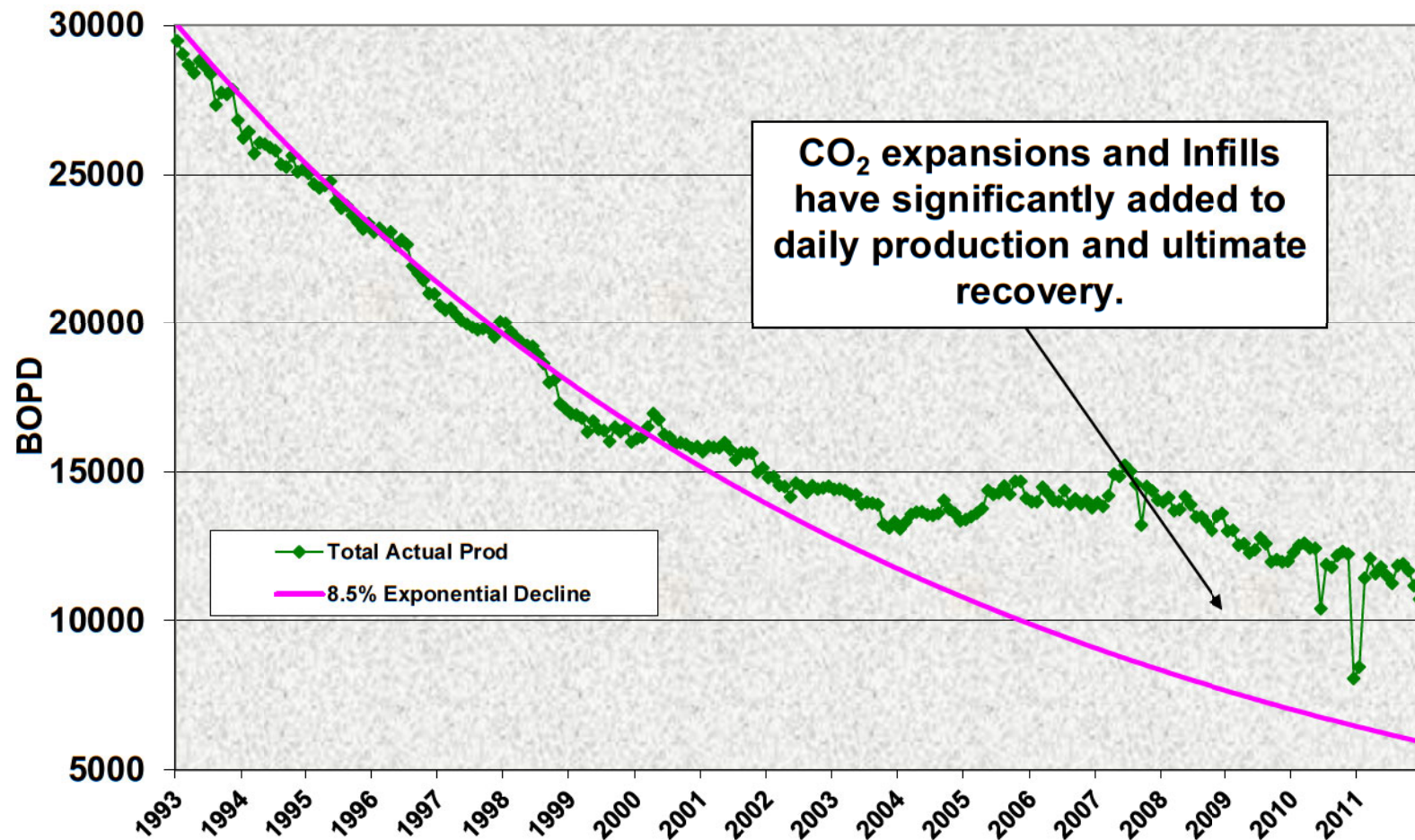


■ 2 focus areas:

- 20-acre infills to the north and west.
- 10-acre infill pilot.



RWSU Project Contribution





Other Projects and Opportunities

▪ Sweep Improvement

- Re-alignment
 - 3 successful pilots.
 - Larger study area being implemented now in the middle of the field.
- Vertical Conformance
 - Large opportunity – but most challenging to implement due to poor wellbore condition.
 - Considering a possible foam CO2 trial.

▪ 10-acre Infill Pilot

- 2 new pilot wells drilled in 2010 are under observation.

Project Evolution Summary



	<u>Initial Design</u>	<u>Actual</u>
WAG Ratio	1:1	Tapered
Half Cycle Slug Size	1.5% HCPV	Varies
Ultimate HCPV Slug Size	30%	46%
Compression Capacity	120 MMCFD	165 MMCFD
Peak CO₂ Purchase Rate	200 MMCFD	150 MMCFD
Ultimate CO₂ Purchase	670 BCF	540 BCF +
NGL Recovery	NO	YES

Tertiary Recovery Project Statistics (October 2011)



Tertiary Incremental Oil Rate (Oil + NGL)	9,170 STB/D
Incremental Cumulative Oil (Oil + NGL)	87 MMSTB (4.8%)
Cum Solvent Purchased	540 BSCF
Cum Solvent Recycled	990 BSCF
Cum Solvent Injected	1,604 BSCF or 46% HCPVSI
Cum Gas Produced to Injected Ratio	69 %
Cum CO2 Utilization - Gross	14.6 MSCF/STB
Cum CO2 Utilization - Net	4.9 MSCF/STB
Average Field WAG Ratio	2.5



Summary

- 1) The Rangely Weber Sand Unit CO₂ flood has been an economically successful project.
- 2) Flood implementation has changed dramatically over time in response to economic factors and operational decisions.
- 3) Technical innovation and flexibility has been critical to field development over time.
- 4) Recent projects in previously under-developed area of field are adding significant production and field life.
- 5) Long history of producing our resources with positive impact to the community and minimal impact to the environment.



Lessons Learned

- **CO2 flooding is a complicated process and you will be surprised at times. Be ready to make changes.**
- **Work closely with operations personnel to identify trends quickly.**
- **WAG tapering and reduced half-cycles have proven to be an effective way to control gas production.**
- **Reduced half cycles can help from both an operational and sweep standpoint.**
- **Facility capacity design is challenging. Plan expansion capability into the design.**

Thank You

