Denbury

The Oyster Bayou CO_2 Flood Case History

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Table of Contents

- Highlights of the CO2 Flood
- Pre-CO_2 History
  - Location and Structure Map of Oyster Bayou
  - Reservoir Data and Pre-CO_2 Development
  - Oyster Bayou Production History
- CO_2 Development
- Well Zone Completions
- Water Injection Performance
- Performance

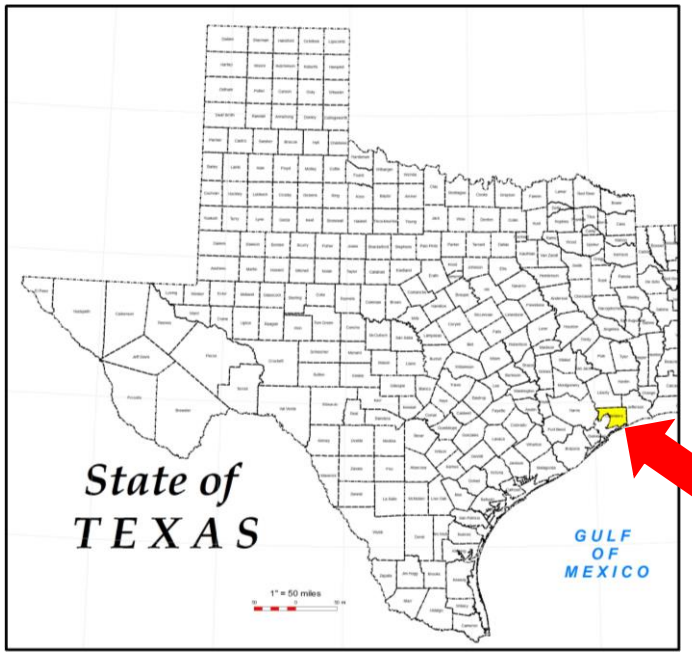
Highlights of the CO2 Flood

Summary

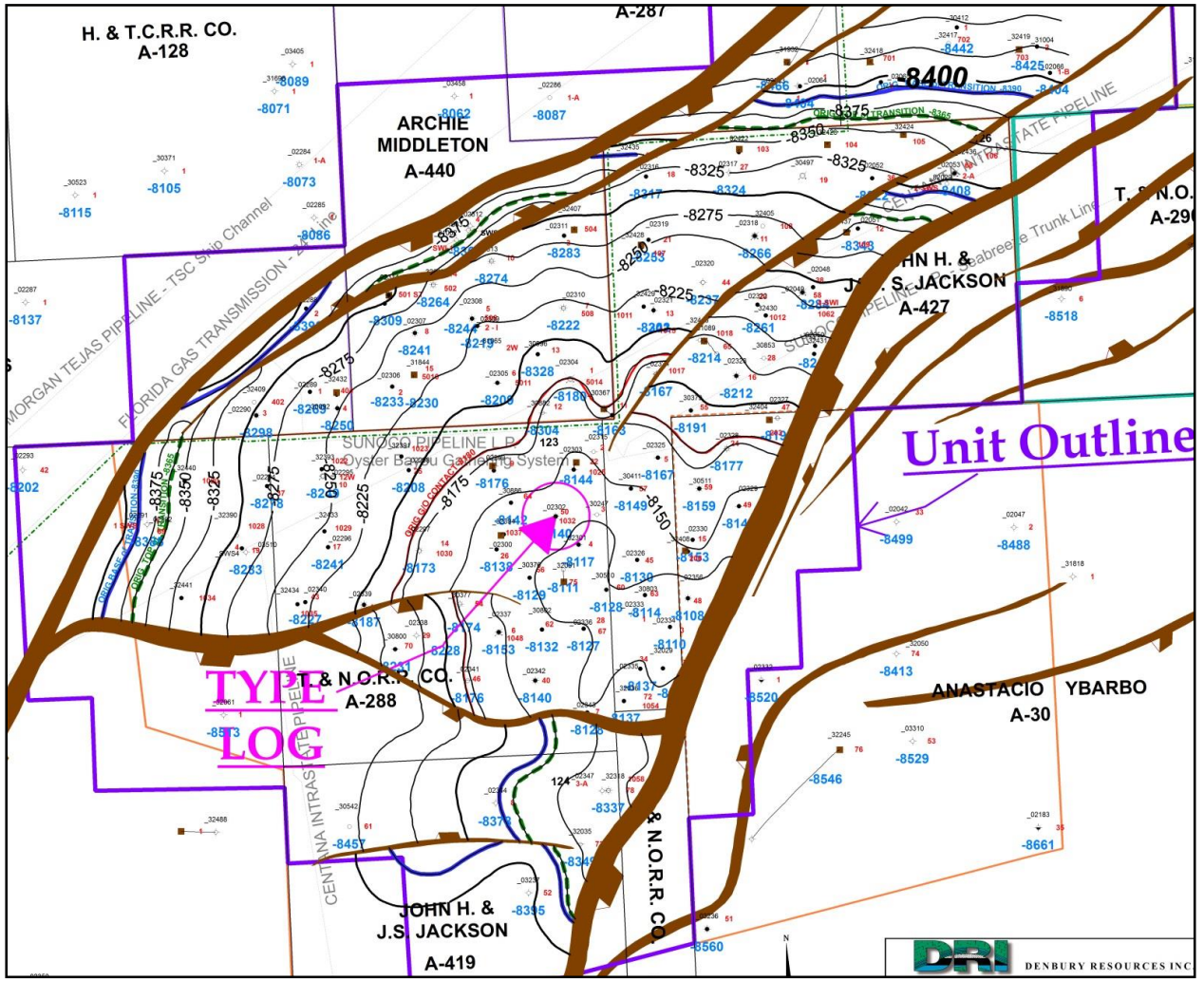
- Oyster Bayou CO_2 flood has been very successful
- Weak aquifer allowed a quick fill-up
- High remaining oil saturation due to the lack of a strong water drive and poor waterflood of the A2
- Early breakthrough was not an issue (good conformance)
- Gas fired compression successfully implemented
- Small facility footprint

Pre-CO_2 History

Location and Structure Map of Oyster Bayou



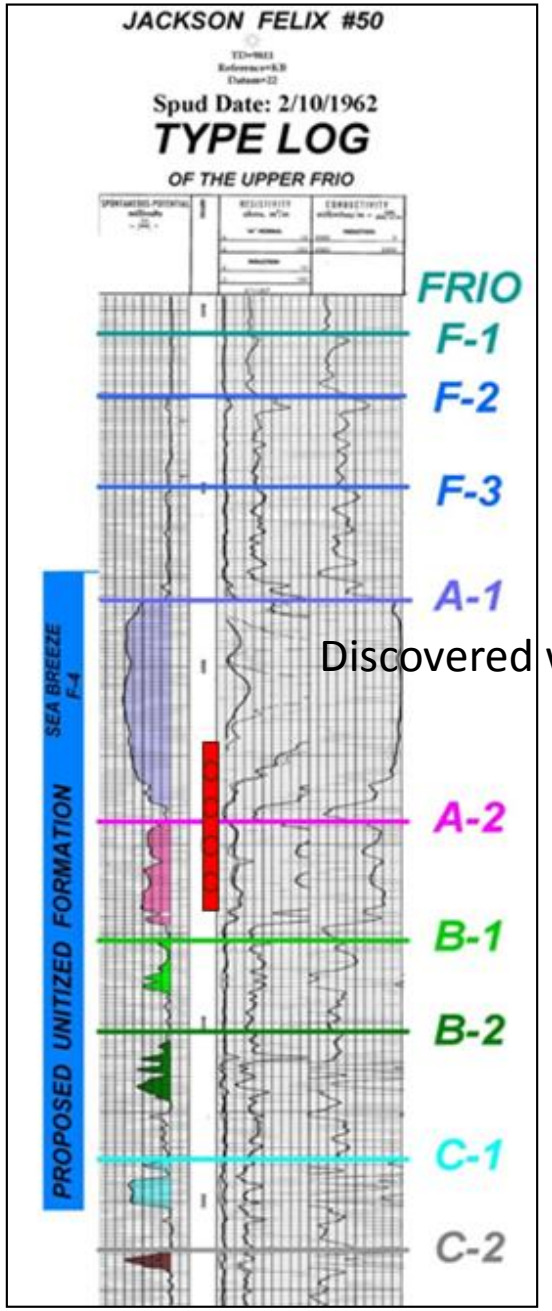
CHAMBERS COUNTY



- Field discovered April 21, 1941
- Located 50 miles E of Houston
- Frio Sand; Faulted Anticline Structure
- Gas Cap Expansion reservoir with small aquifer and peripheral water injection
- 2300 acres developed with 52 oil wells drilled on 40 acre spacing

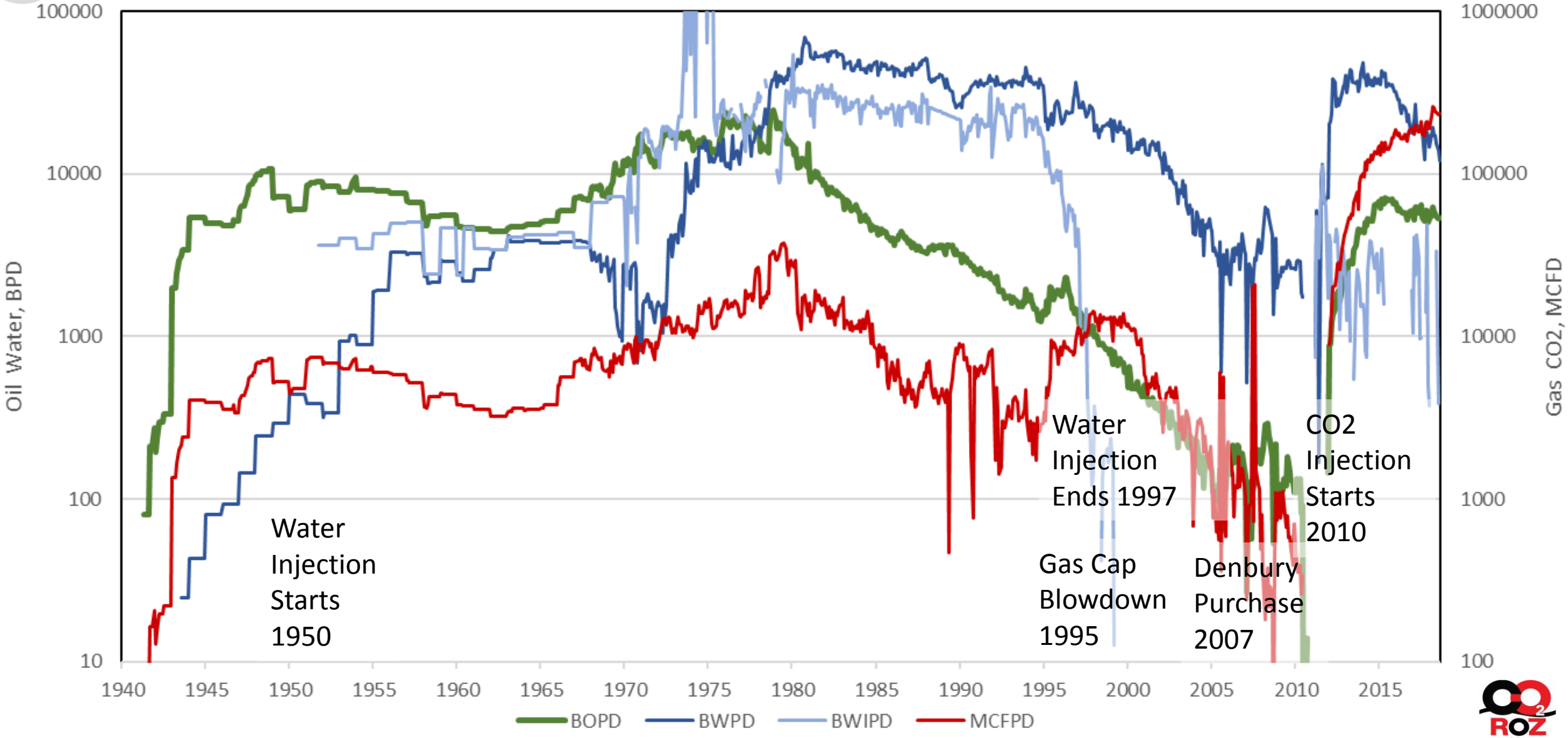
Reservoir Data and Pre-CO_2 Development

Producing Formation Names	A1 / A2 (Frio)
Datum Depth / GOC / WOC, ft ss	8240 / 8180 / 8391
Temperature, °F	190
Initial Pressure and Saturation Pressure, psig	3800
API Gravity	39.5
Gas Gravity	0.63
Water Salinity, ppm	60,000
Formation Volume Factor, rb/STB	1.354
Average Porosity A1 / A2, %	28.5 / 27.8
Average Perm A1 / A2, md	2000 / 275
Average Swi A1 / A2, %	16 / 31.1
Net Thickness, ft	115.6 / 39.7
Oil Recovered (Pre-CO_2), million STB	142
Oil Recovery Factor (Pre-CO_2), %	62.8



Discovered with gas cap

Oyster Bayou Production History

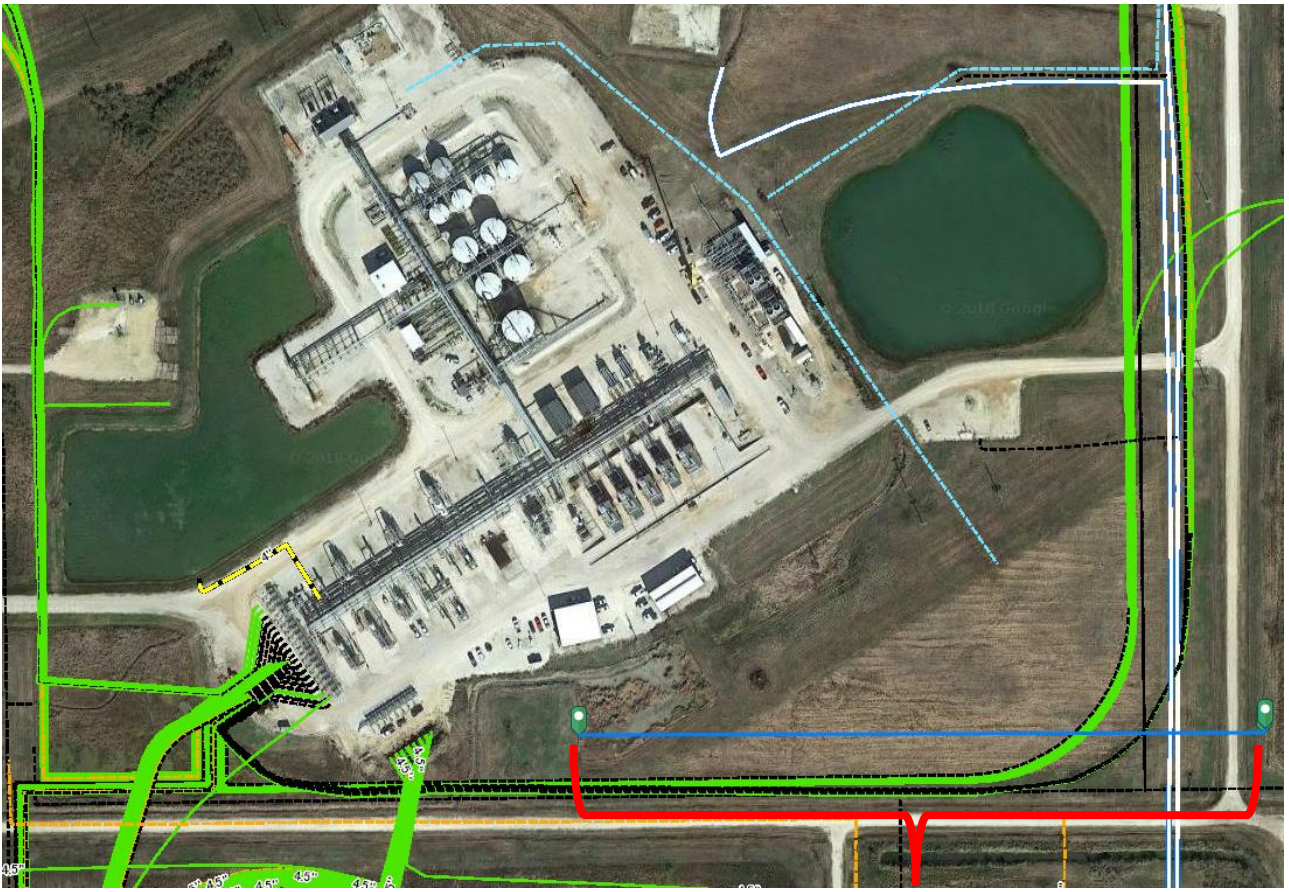


CO_2 Development

Before Facility was built

- Removed old facilities
- Grading in new location

Facility



1000 feet

- Gas Fired Compressors
- Central gathering and processing
- Central testing

Pictures of the field

1st Injection June of 2010

Pre-CO_2 Flood Predictions from Simulation

How close were they??

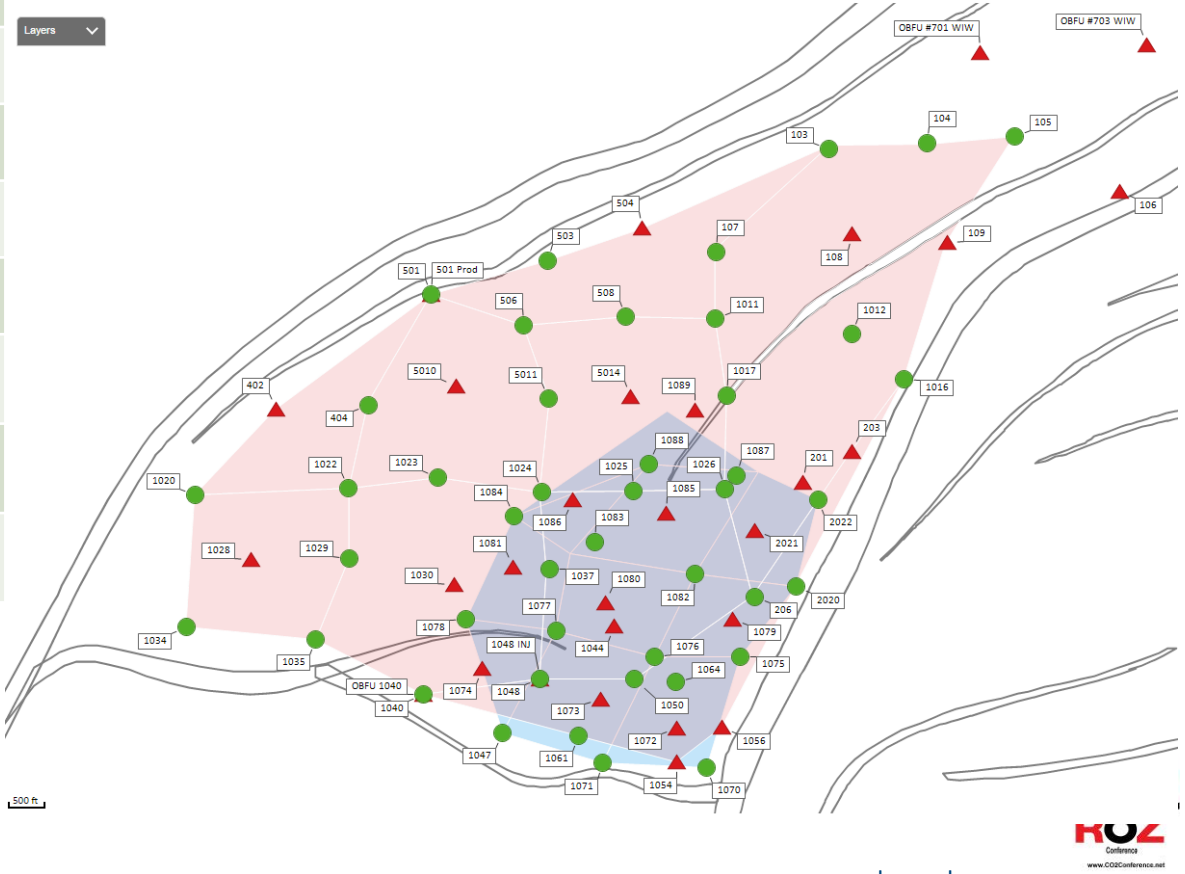
- Strong Gravity Override of CO_2 at all Stages
- Full Zone Well Completions Best
- A2 Sand Response/Contribution Insignificant
- A1 Oil Recovery – 9.7% to 12.0% of OOIP
- Net CO_2 Utilization – 12.4 MSCF/STB to 17.1 MSCF/STB
- Gross CO_2 Utilization – 55.1 MSCF/STB to 69.6 MSCF/STB

CO_2 Development Details

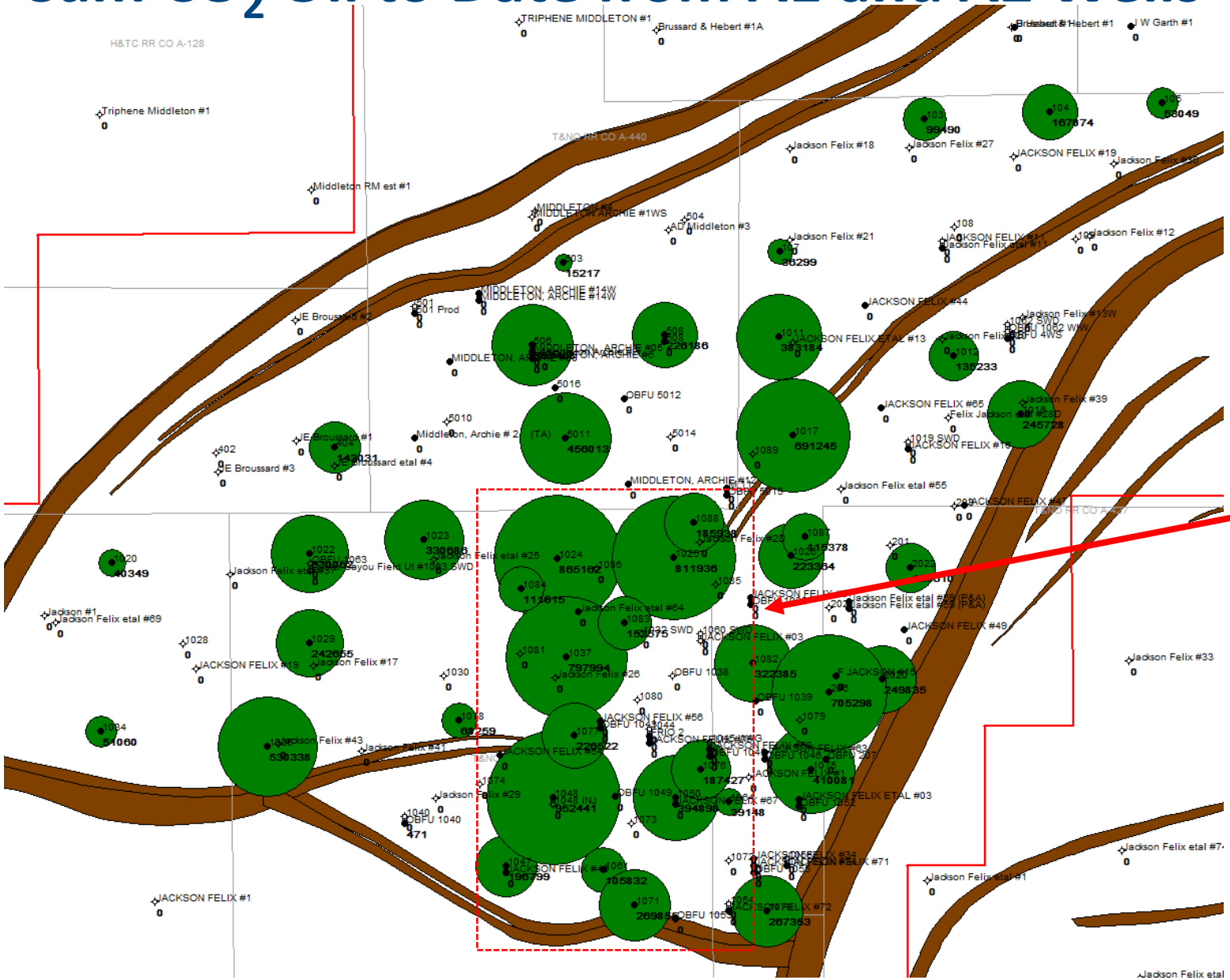
Wells	Number
Reservoir Operating Pressure	4,000 psi
MMP	4,000 psi
CO_2 Flood Type	Miscible
Producer wells	30
Injector wells	24
HP Compression, MMscf/d	259
LP Compression, MMscf/d	16
Development Area OOIP A1 / A2, MMBO	162.5 / 25.5
Cum Gross Tertiary Prod A1 / A2, MMBO	8.9 / 3.1
Cum Tertiary Recovery Factor A1 / A2, %	5.5 / 12.1

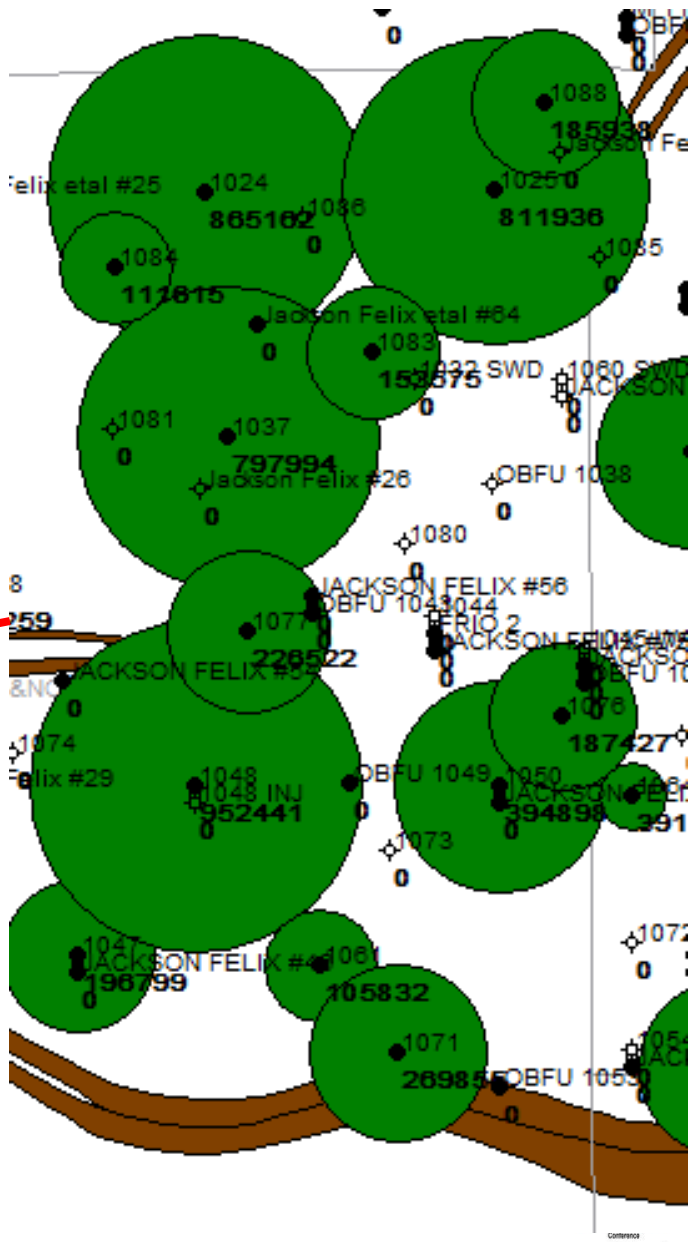
Current CO_2 Development:

- A1 and A2 being flooded separately
- A1 patterns on 160 acre 9-spots
- A2 patterns on 80 acre 5-spots
- Oil production ~5,700 bbl/day



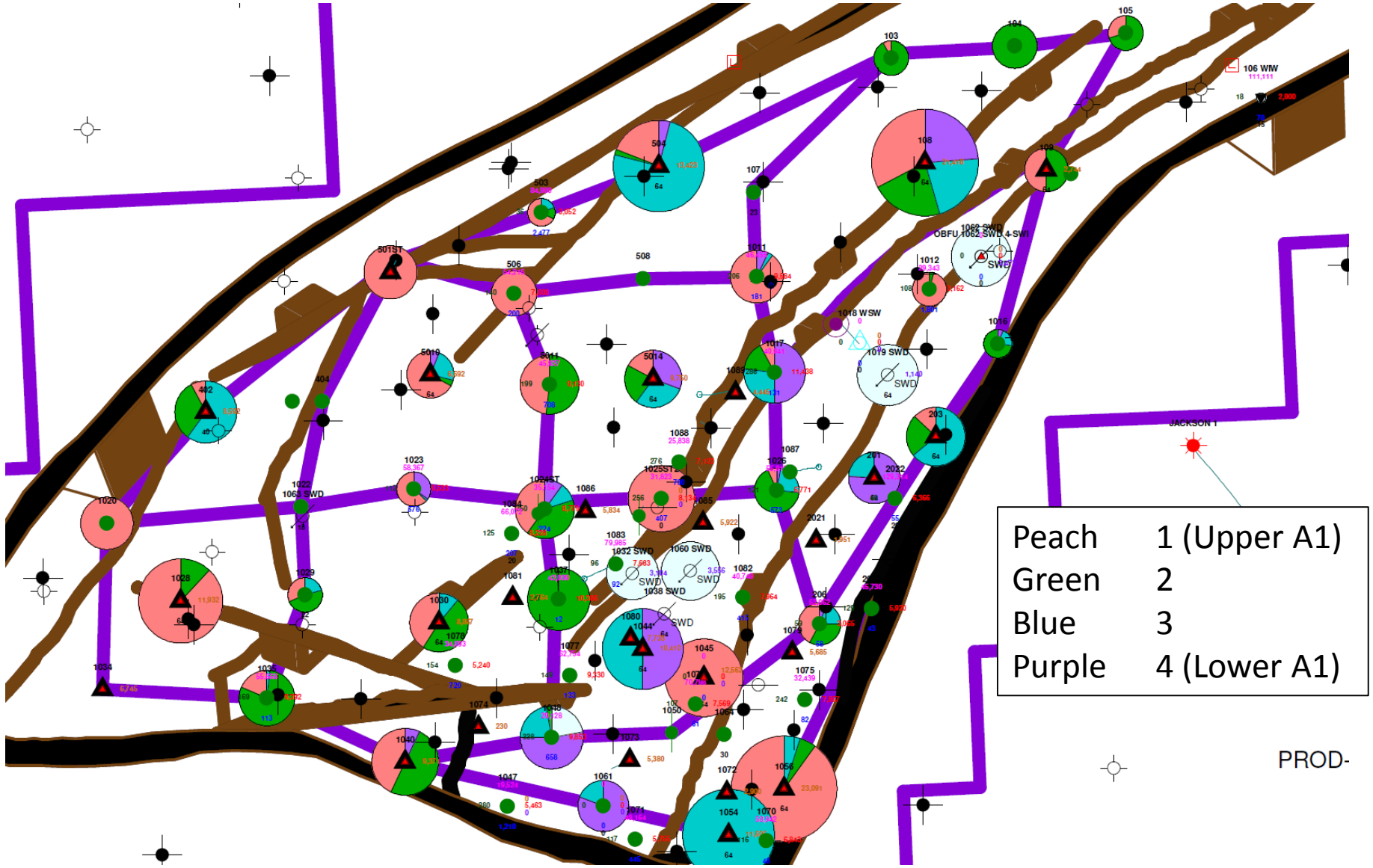
Cum CO_2 Oil to Date from A1 and A2 Wells



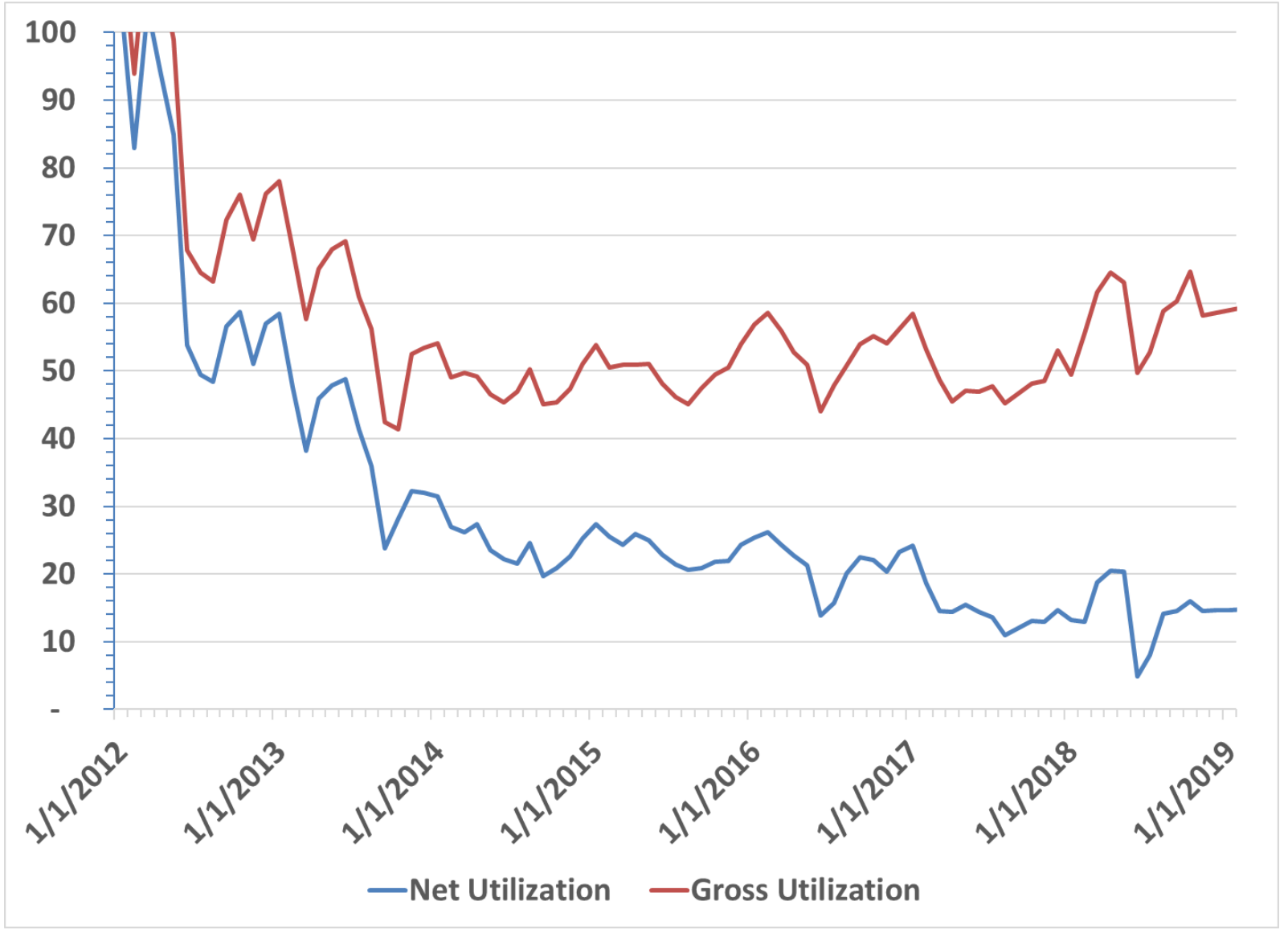


Well Zone Completions

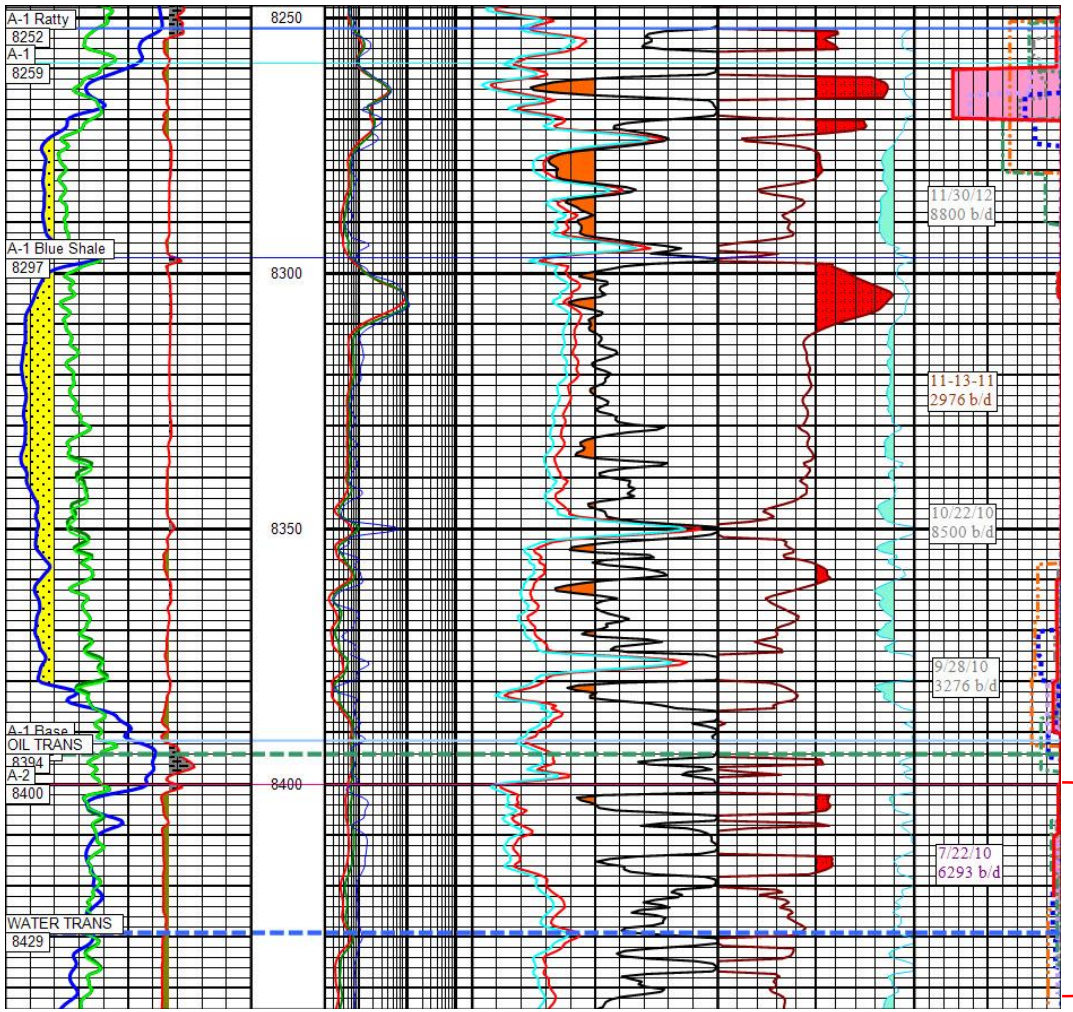
A1 contribution from each zone (total of 4 identified here)

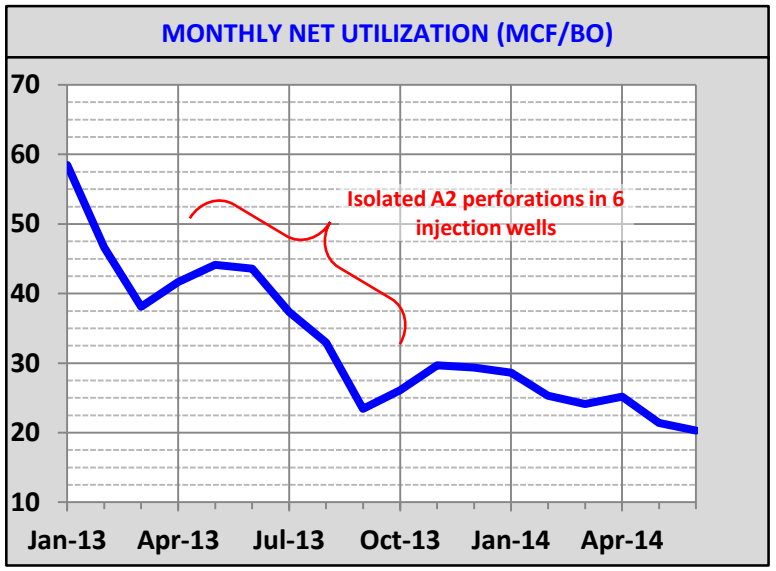


A1 Net and Gross Utilization to date



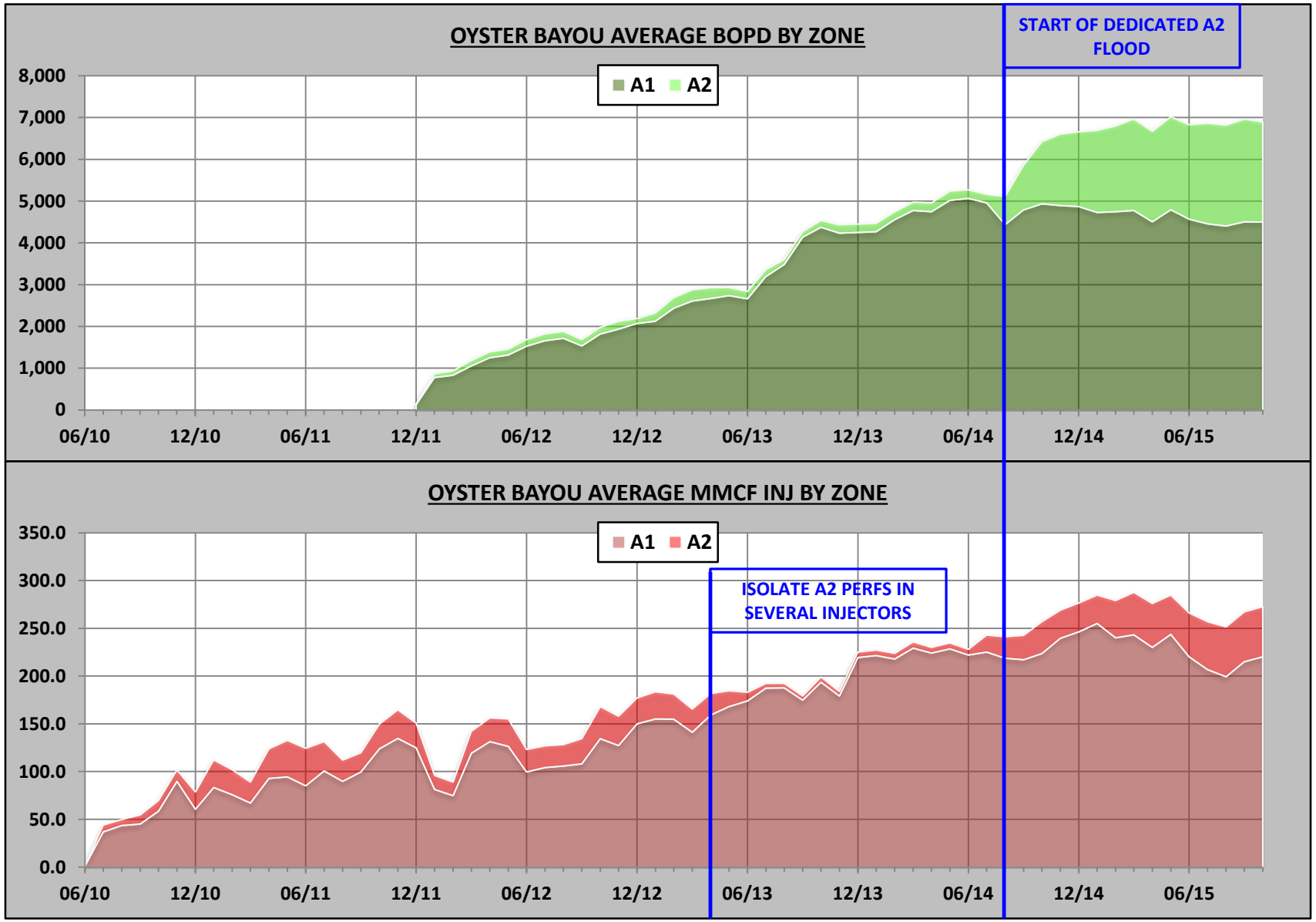
Mid Development Change
Isolated A2 Injection and Production





Historically, injection logs indicate <15% total injection to A2. Example is typical of other injectors. A2 was subsequently isolated in this well

Current Development – Dedicated A1 & A2 Floods



A2 Development Area

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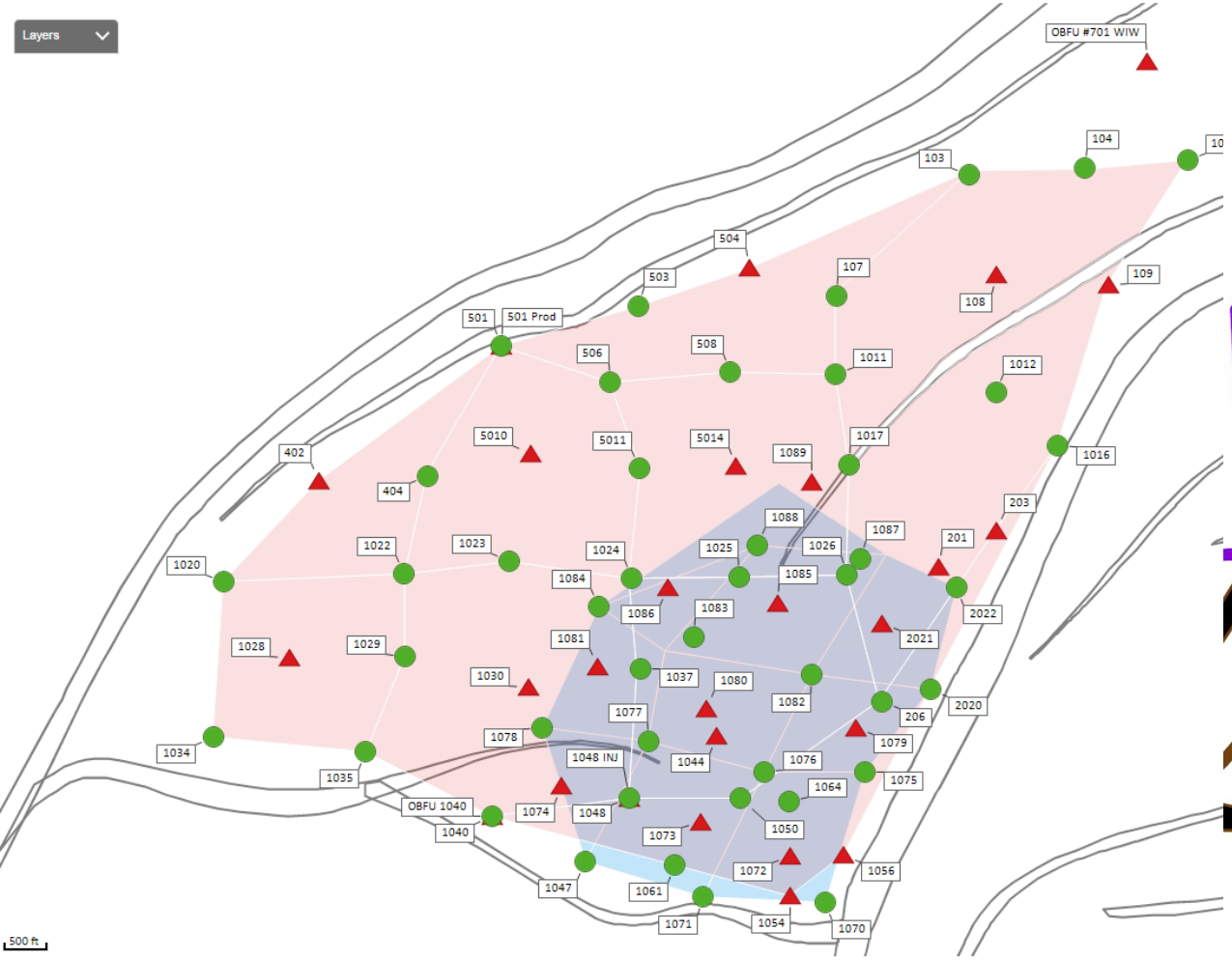
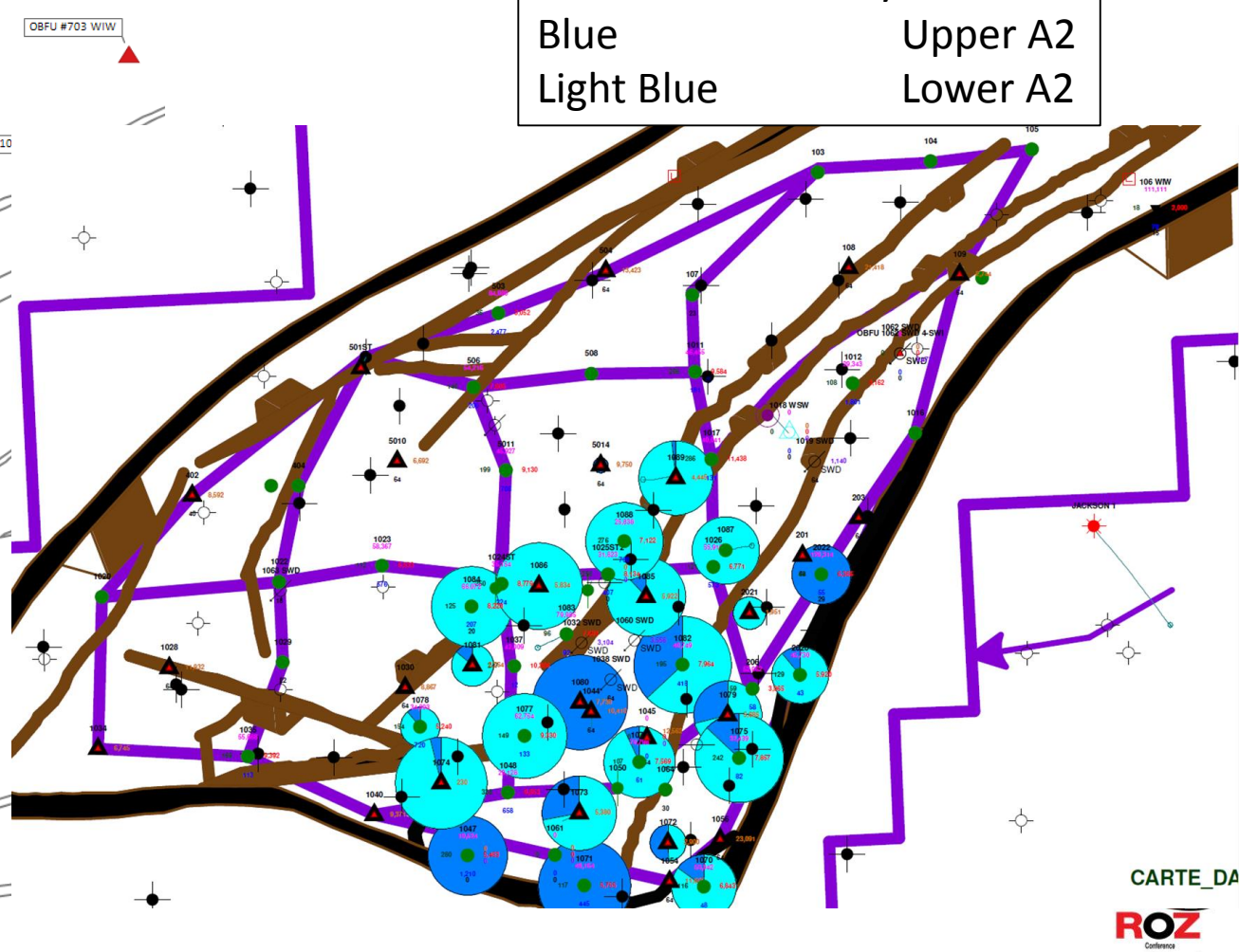
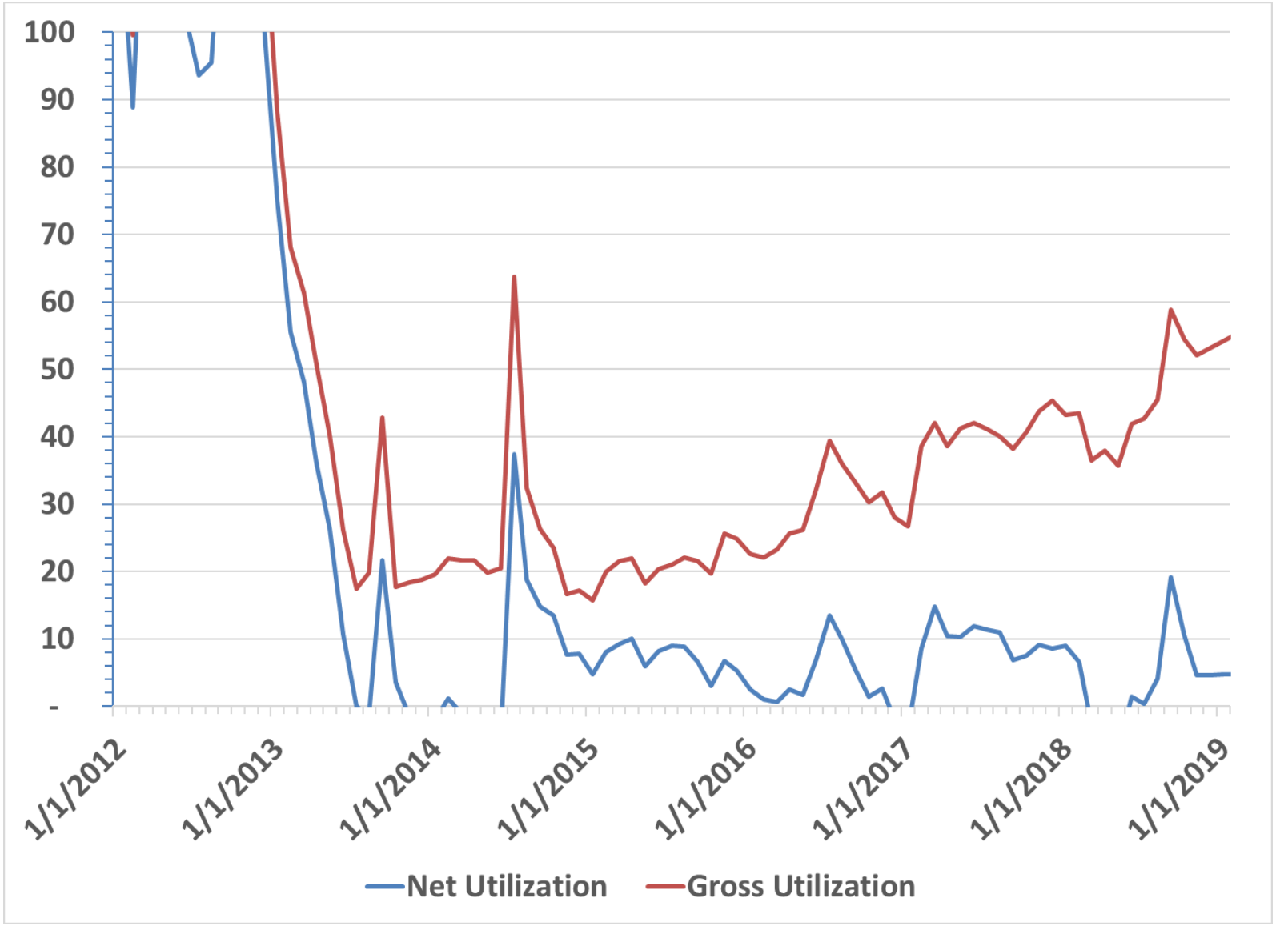


A2 contributions by zone

Blue	Upper A2
Light Blue	Lower A2



A2 Net and Gross Utilization to date

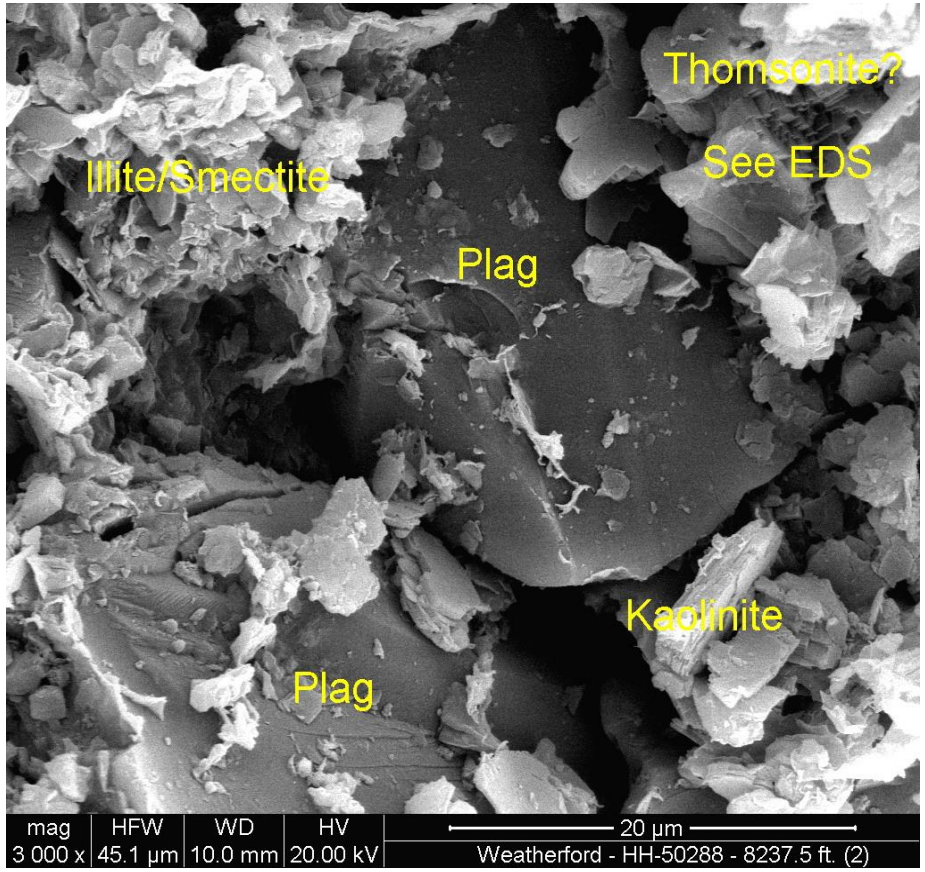


Water Injection Performance

Or why we are recovering more than expected with CO_2

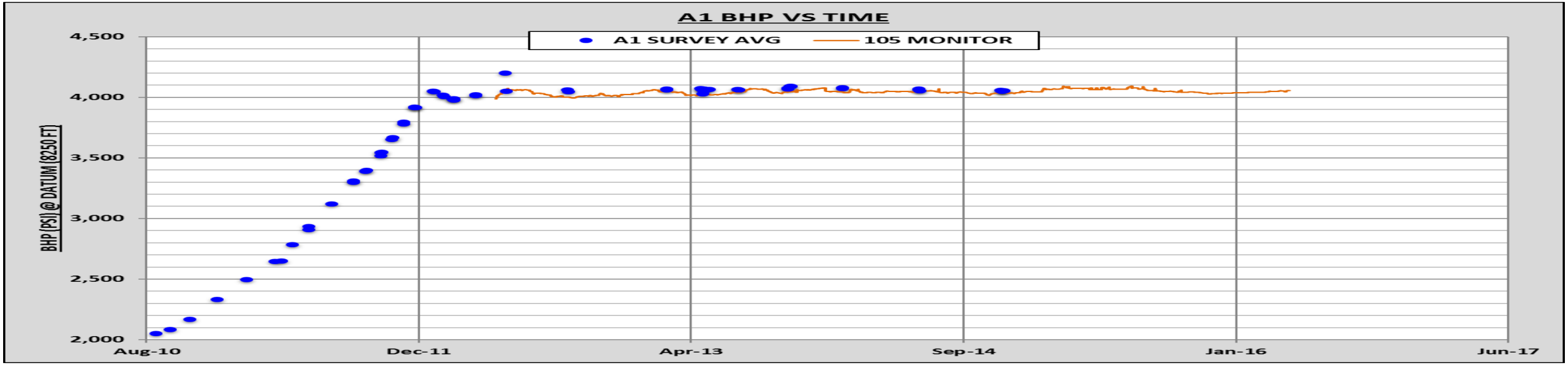
Water Injectivity problems in A1 and A2 sand

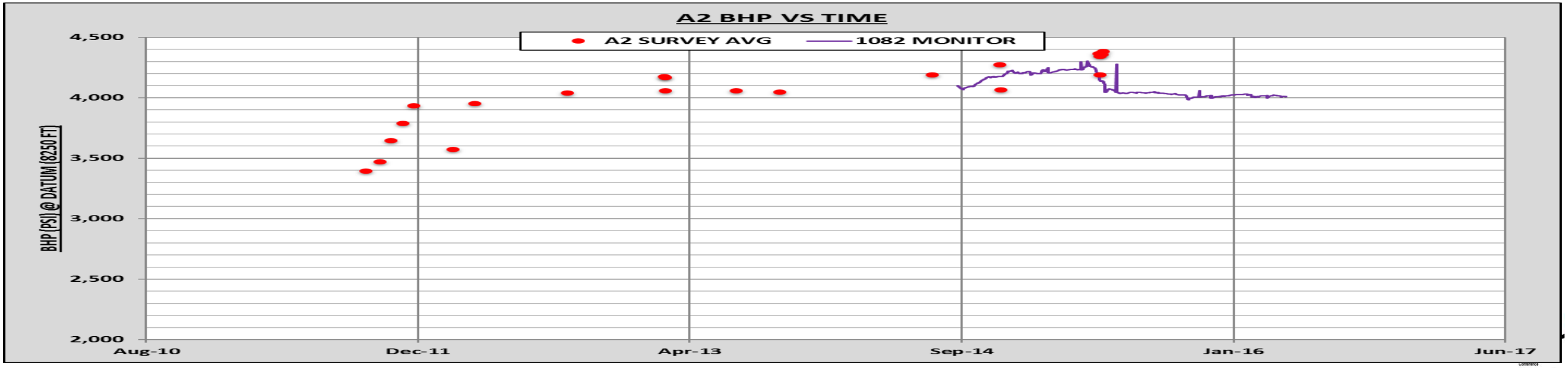
- Reservoir damage due to previous water flooding
- The dominant clay type is Smectite (swelling) followed by mix. Smectite/Illite.
- The majority of the examined thin sections show damaged textures.
- A2 has more swelling clay and feldspars percentage compared to A1.



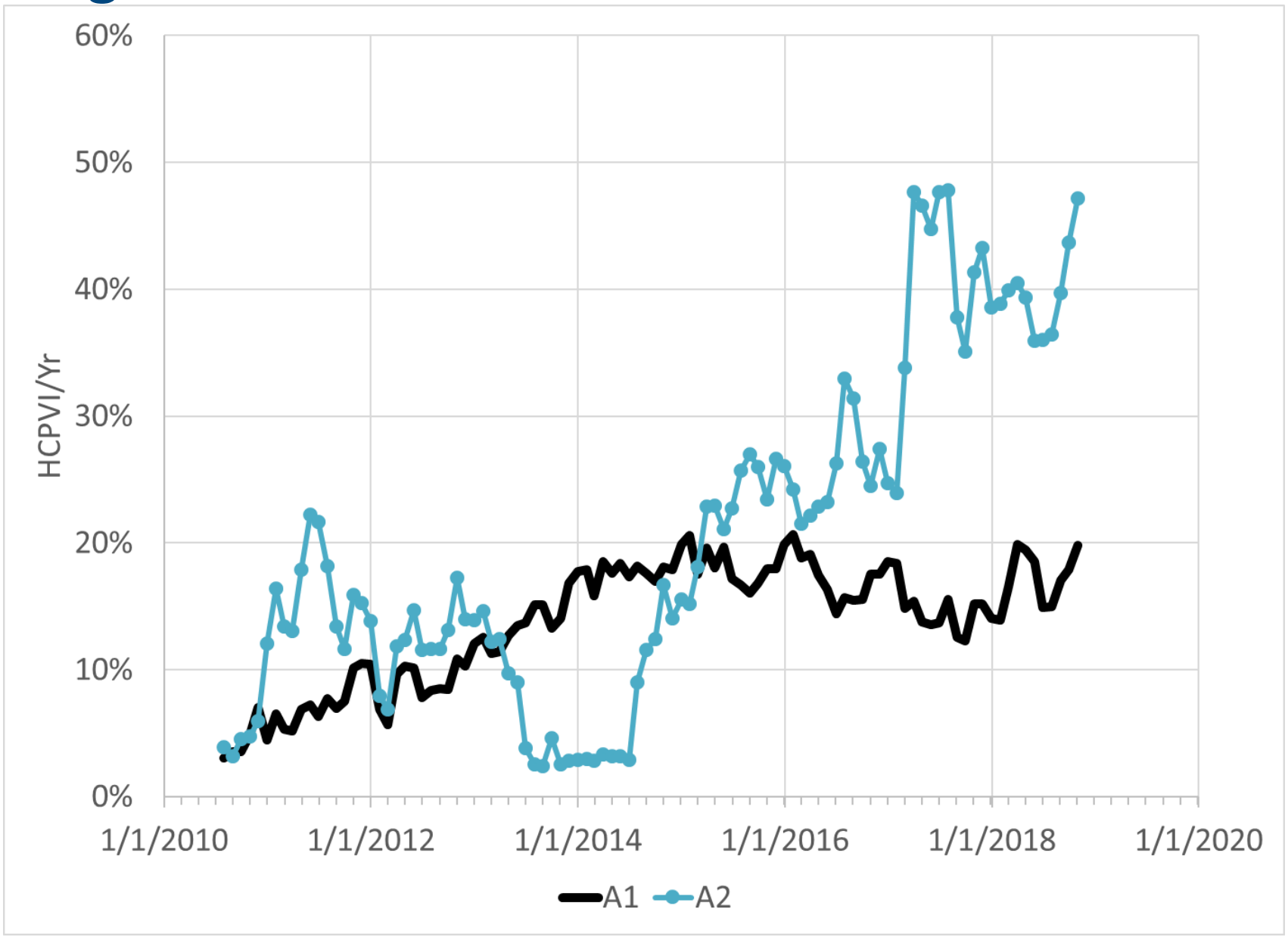
Performance

Re-pressurization history

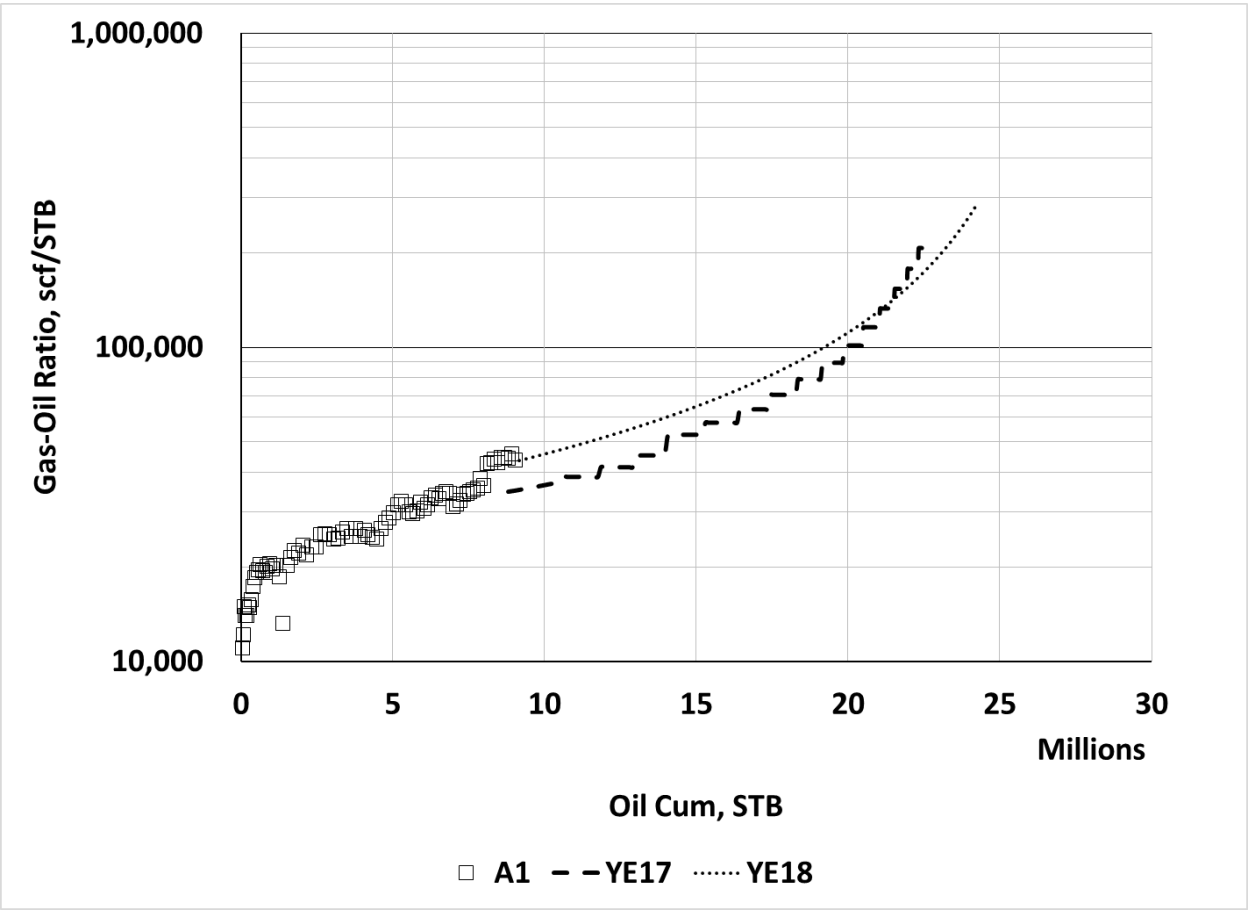


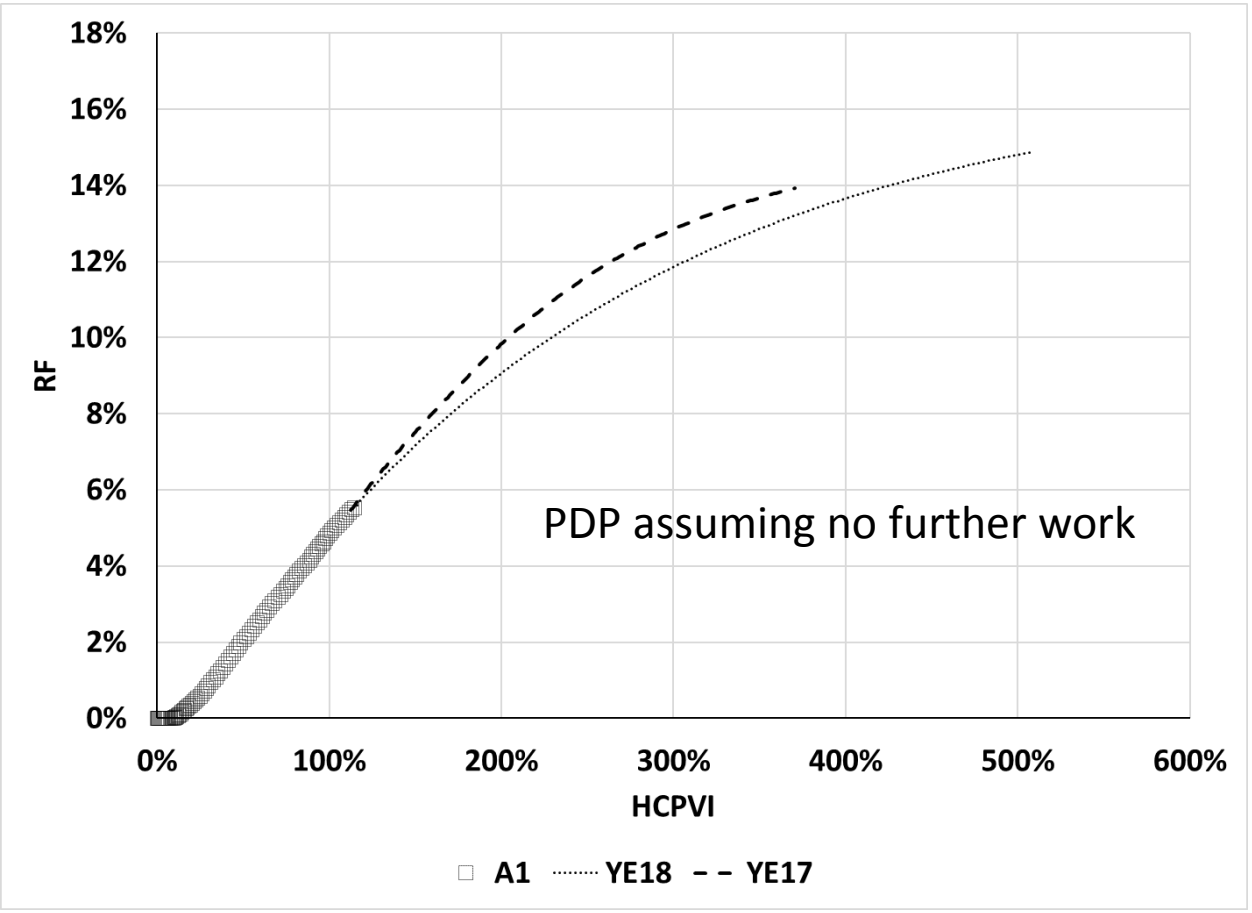


Processing Rate



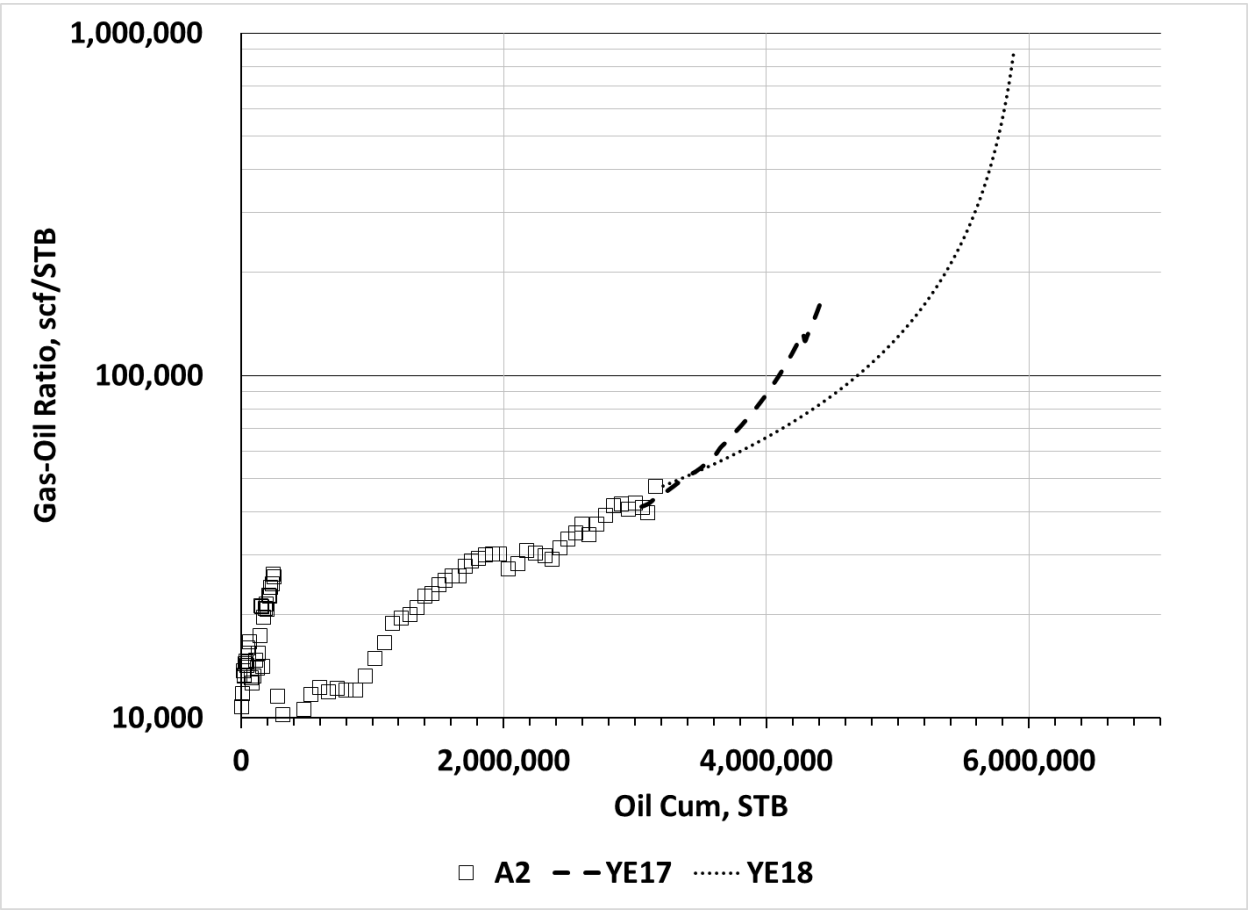
A1 GOR vs Oil Cumulative and Dimensionless Recovery Curve

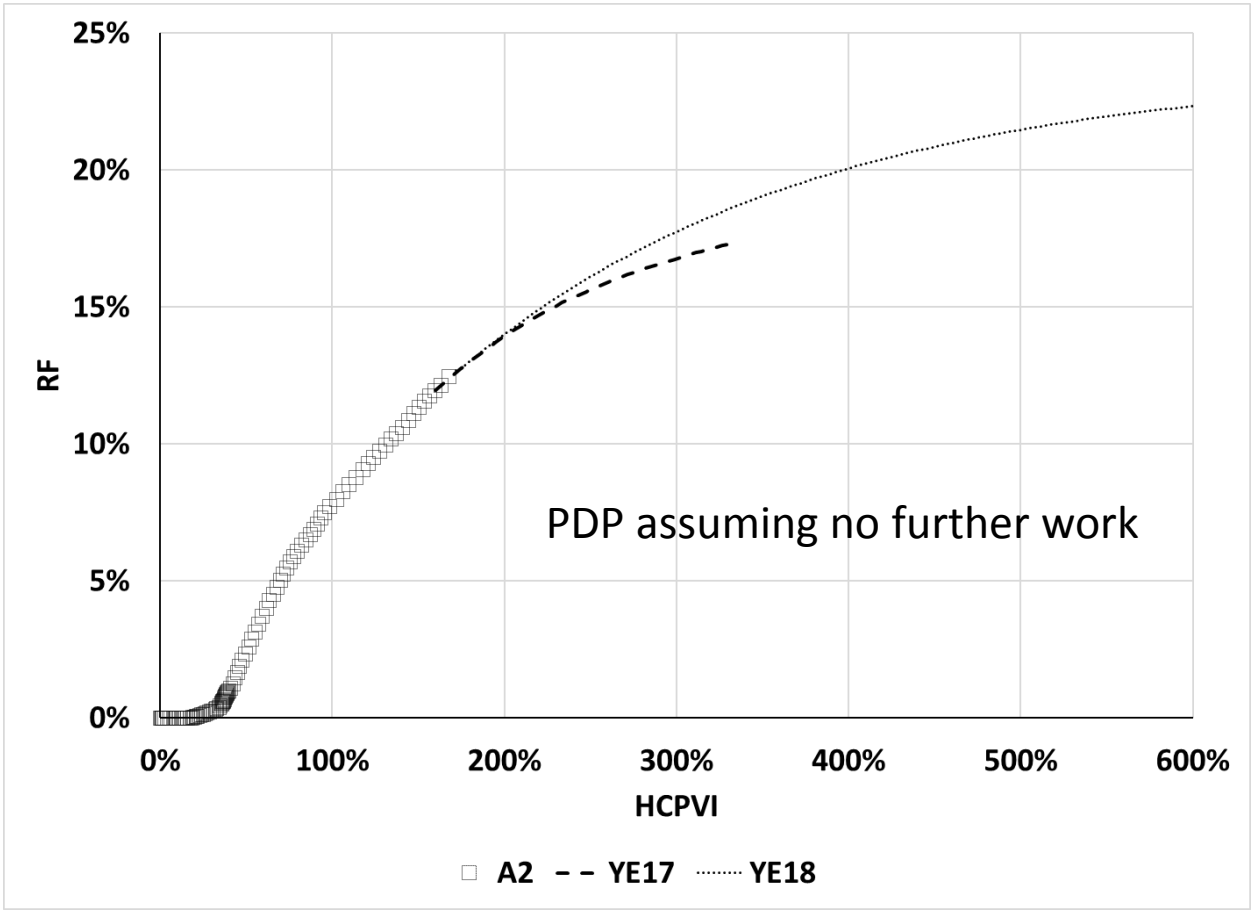




Reservoir	OOIP	Cum to date As of 9/2018	Recovery Factor As of 9/2018
A1	162,497 MBO	8,909 MBO	5.5%

A2 GOR vs Oil Cumulative and Dimensionless Recovery Curve





Reservoir	OOIP	Cum to date As of 9/2018	Recovery Factor As of 9/2018
A2	25,536 MBO	3,099 MBO	12.1%

OOIP & Recovery Factor Table

Reservoir	OOIP	Cum to date As of 9/2018	Recovery Factor As of 9/2018
A1	162,497 MBO	8,909 MBO	5.5%
A2	25,536 MBO	3,099 MBO	12.1%
Total	188,033 MBO	12,008 MBO	Avg. RF 6.4%

PDP assuming no further work
Many improvements can be made in the future with conformance work