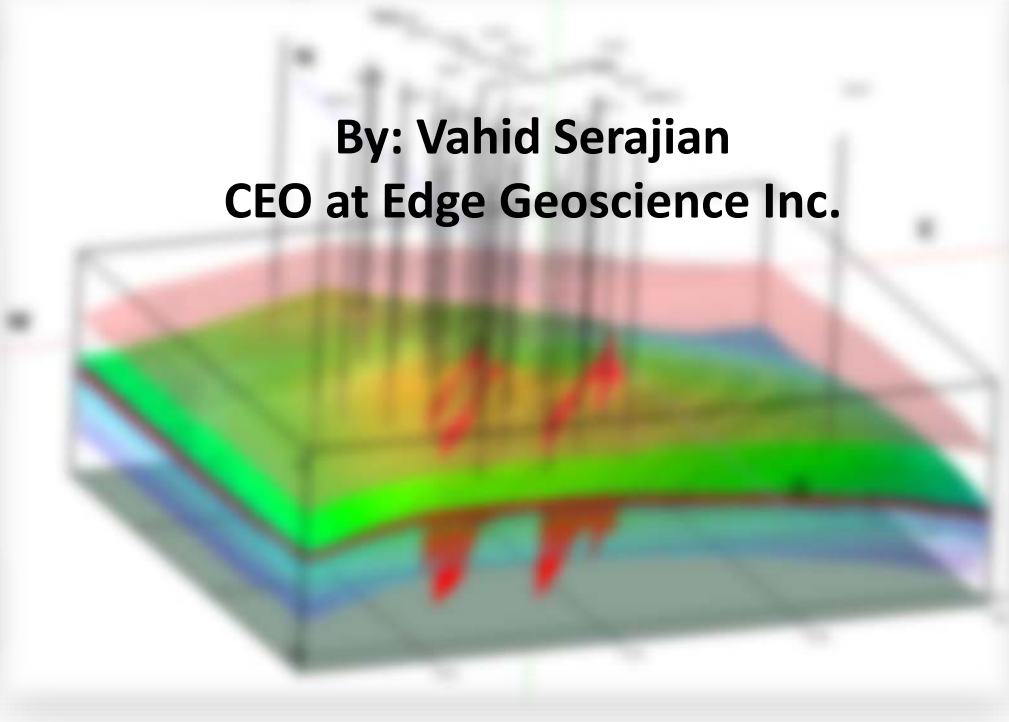
Summary of the 2019-2020 Reservoir Simulation, History Matching and Forecast for Bush Dome Gas Reservoir



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17 July 2020

Disclaimer

- All the simulations, history matching, predictions and forecast performed at Cliffside (Bush Dome) reservoir are based on the information received from BLM and using common reservoir and production engineering solutions. The forecasted values are based on current conditions. Change in reservoir management (especially after 2021), market conditions, operational issues, … could significantly change the results. Edge Geoscience Inc. doesn't guarantee that the forecasted results will match the reservoir performance.

Scope of the Talk:

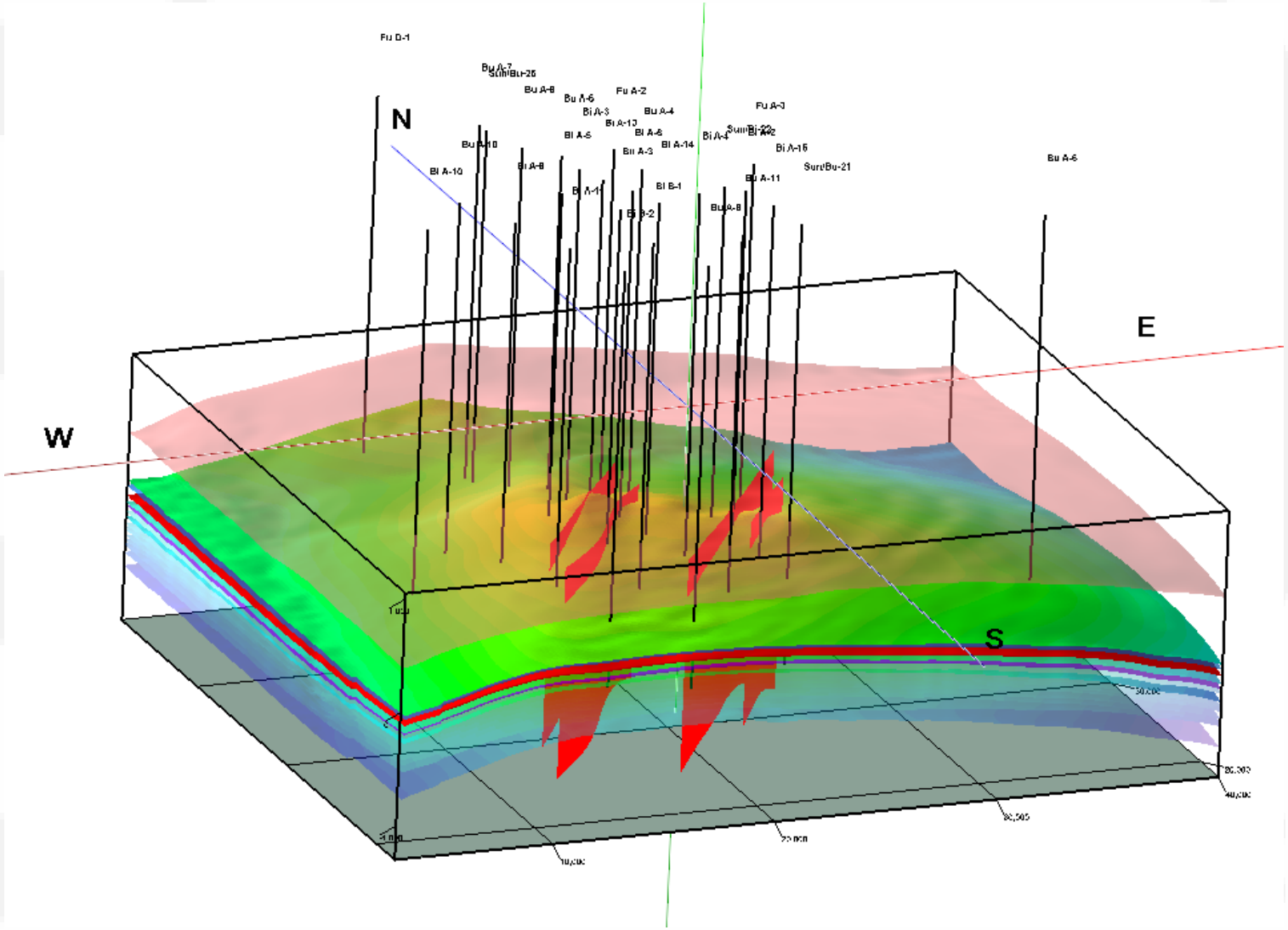
- Introduction
- Geologic and Petrophysical Conditions at Bush Dome
- Current Reservoir Conditions at Bush Dome
- Results of the Pressure Transient Analysis
- Wells' Priorities for Possible Acidizing Operation
- Review of Reservoir's Production Performance
- 2019-20 FY Statistical Results and Comparisons with Previous Years
- Conclusions and summary

Introduction

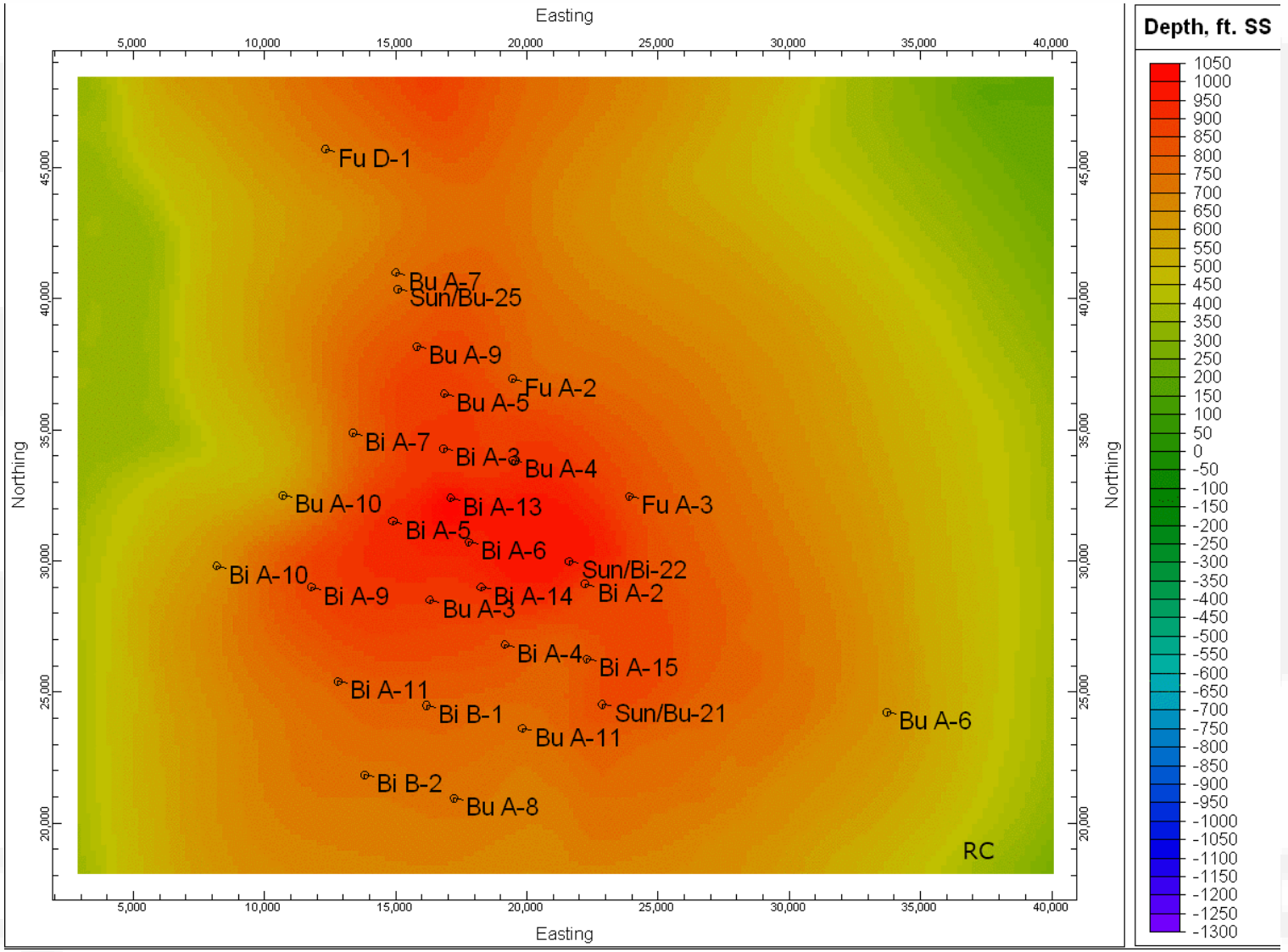
- In 2018, Edge Geoscience Inc. (EGI) was awarded by the Bureau of Land Management (BLM) to perform geologic, reservoir engineering and forecast studies for Bush Dome reservoir until 2023.
- Edge Geoscience Inc. and its staff have proven record of performing similar geologic, geomechanical and reservoir simulation studies for major oil and gas reservoirs globally.
- Compared to the previous versions of reservoir model built by NITEC, the current version built by EGI is much more detailed, follows common commercial format and has improved history matching and forecast quality.

GEOLOGIC AND PETROPHYSICAL CONDITIONS AT BUSH DOME

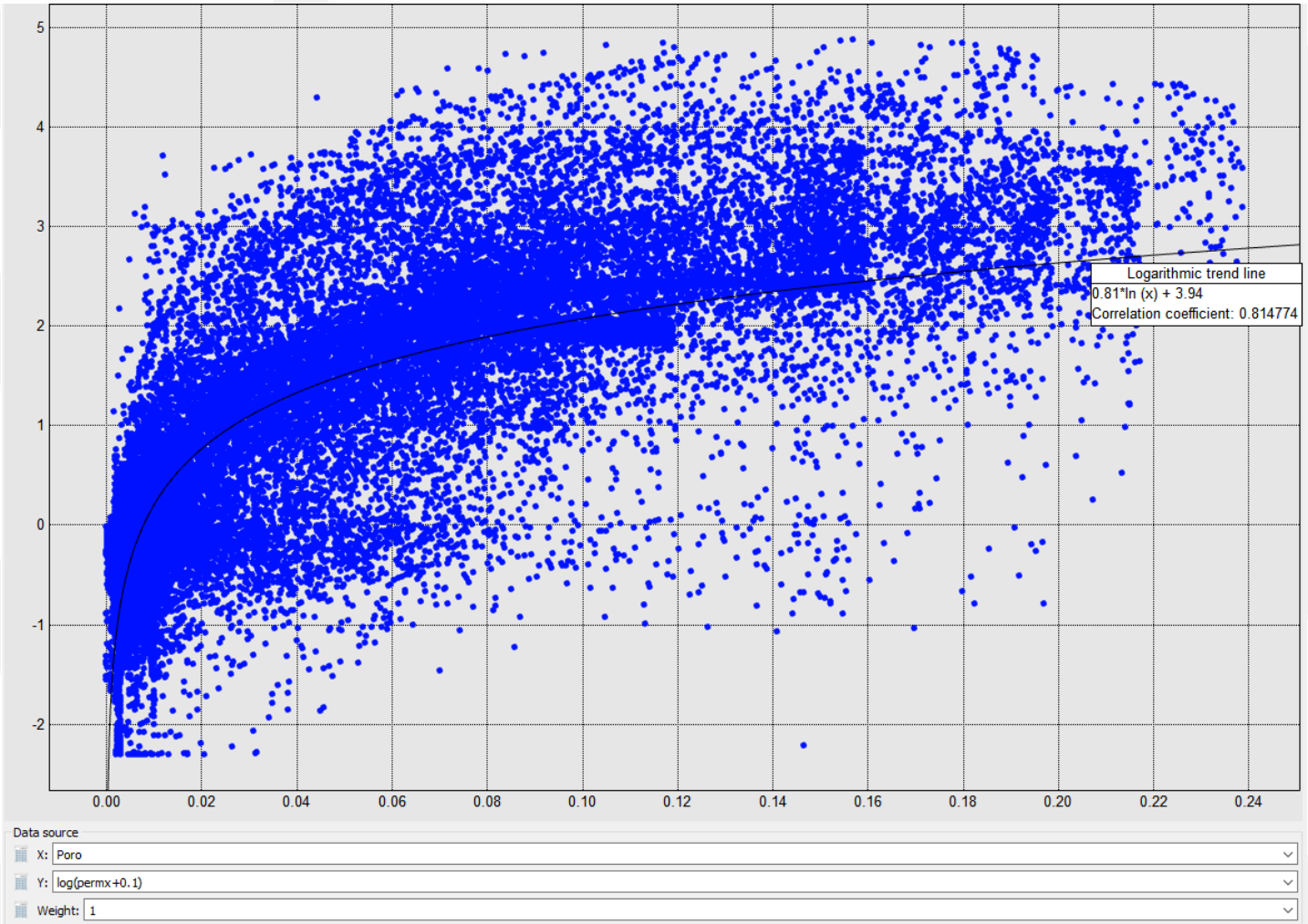
3D view of the Geologic Model



Formation Tops (Animated)



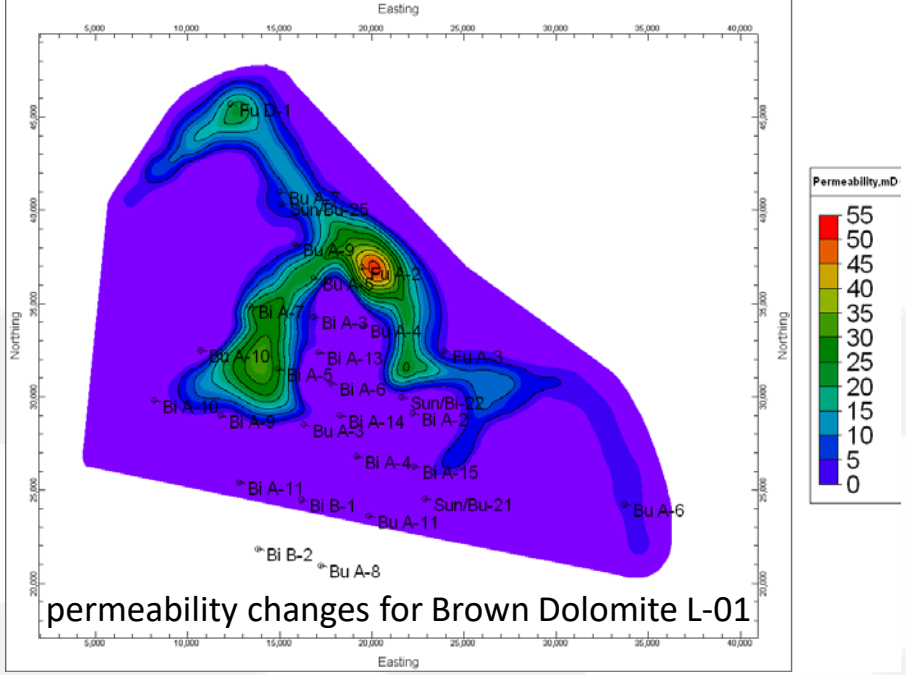
Petrophysical Updates for Further Skin Damage Studies



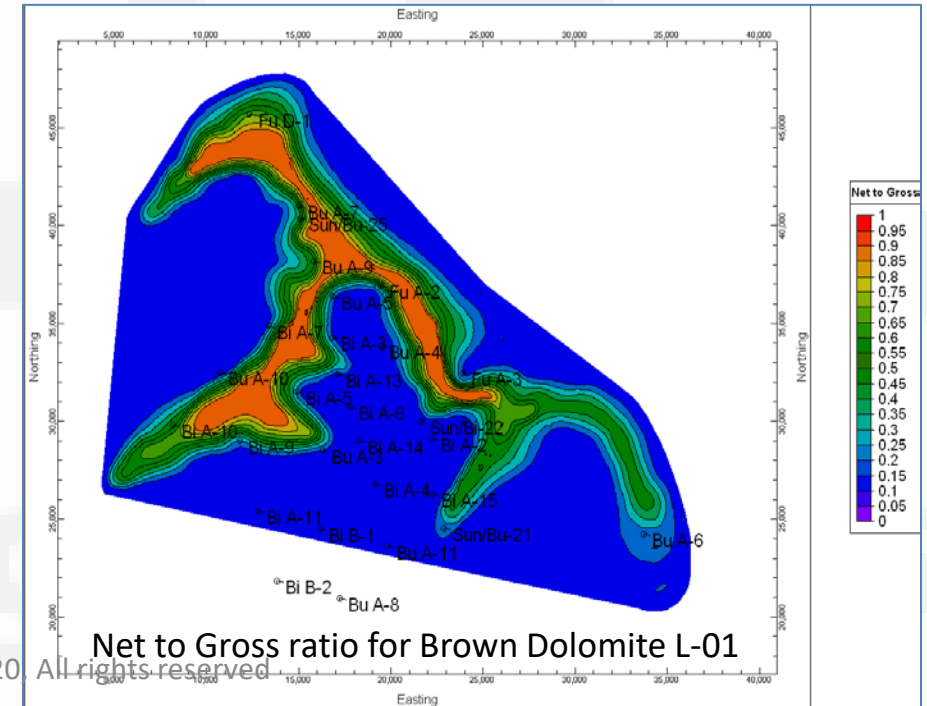
Permeability Summary

Formation	Interpreted Geological Layer	Bi-A1	Bi-A2	Bi-A3	Bi-A4	Bi-A5	Bi-A6	Bi-A7	Bi-A9	Bi-A10	Bi-A11	Bi-A13	Bi-A14	Bi-A15	Bi-B1	Bi-B2	Bu-A1	Bu-A2	Bu-A3	Bu-A4	Bu-A5	Bu-A6	Bu-A7	Bu-A8	Bu-A9	Bu-A10	Bu-A11	Bu-B1	Bu-B2	Fu-1	Fu-A1	Fu-A2	Fu-A3
Panhandle	P-1																															
	P-2																															
	P-3																															
	P-4																															
	P-5		---	---	1.646	19.13	---	12	---	0.349	---	1.356	---	---	---	---	1.2	---	---	12.45	---	2.5	3.59	---	2.984	---	---	1.2	41.6	---	6.25	3.94	---
	P-6	---	---	0.852	---	12.48	---	9	---	0.825	---	1.211	---	---	---	---	10	---	47.3	45.15	---	4.66	---	9.54	1.542	---	---		---	---	7.1	4.68	---
	P-7	---	1.105	0.376	---	---	---	---	---	1.011	---	1.632	---	---	---	---	5	---	3.3	---	2.49	3.36	3.6	---	3.593	---	---		---	---	12	36.9	---
FS BROWN DOLOMITE		2	2	1	1	2	1	2	2	2	1	2	2	2	1	1	2	3	2	1	2	1	2	2	2	1	2	2	2	2	2	2	1
Bronw Dolommite	L-1	0.84	---	1.83	---	79.74	---	50.00	1.41	1.24	---	1.432	---	---	---	---	3	4	0.74	---	20.50	3.19	7.23	---	3.37	---	---	2.00	21.15	---	1.00	37.7	3.26
	L-2	0.83	0.33	1.79	0.83	4.72	0.84	3.00		1.53	---	7.066	---	---	---	---	1	1	0.76	---	7.75	0.91	3.27	---	2.97	15.63	---	0.91	13.28	12.00	8.00	1.72	1.83
	L-3	1	3.44	---	1.69	7.58	0.83	3.00	0.74	---	0.05	6.412	---	13.8	---	---	12	9	2.52	13.05	3.58	1.44	4.48	---	2.48	3.64	0.51	1.42	16.53	3.64	6.00	3.21	---
	L-4	14	15.17	0.20	5.10	13.75	1.04	14.00	22.05	0.37	1.40	14.245	0.57	13.9	8.21	---	5	3	3.09	17.74	32.38	---	4.64	14.31	1.11	8.84	16.89	---	11.73	8.84	0.83	1.19	0.74
	L-5	20	5.84	0.80	2.65	21.78	1.95	22.00	16.64	0.67	3.43	11.005	11.1	5.42	6.12	11	10	5	13.10	7.36	23.87	5.66	11.37	9.77	4.13	1.58	46.97	4.66	19.57	1.58	8.00	1.5	2.06
	L-6	1	2.00	4.30	3.01	1.08	5.88	1.00	49.40	---	1.02	2.457	9.436	4.91	3.43	0.57	8.2	3.2	9.10	8.20	43.40	24.08	---	52.25	5.81	1.67	12.50	24.08	7.21	1.67	30.50	5.63	28.55
	L-7	---	3.60	4.29	5.15	---	20.54	---	73.39	1.81	1.38	2.230	14.87	7.72	5.84	0.23	12	15	0.50	---	---	23.69	---	5.74	3.61	---	11.17	23.69	14.57	---	60.00	7.1	80.87
	L-8		---	55.62	---	---	---	---	---	---	1.66	21.559	10.95	42.1	23.2	---	---	---	---	---	---	---	---	35.51	---	---	5.75	3.00	---	---	1.00	---	---

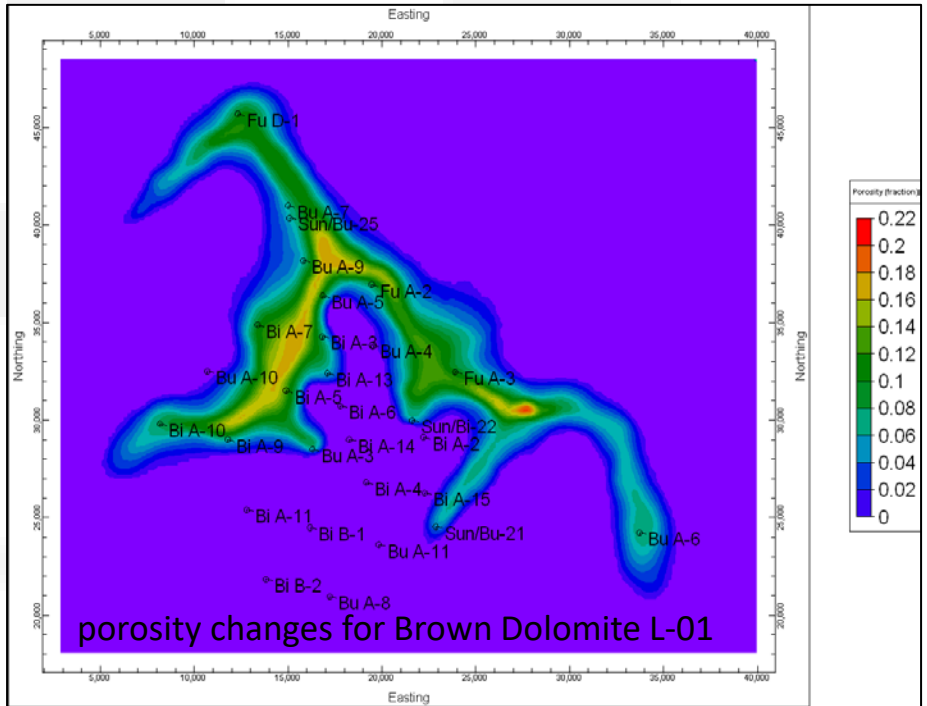
Samples of Petrophysical Interpretations at each layer (Here:L01)



permeability changes for Brown Dolomite L-01



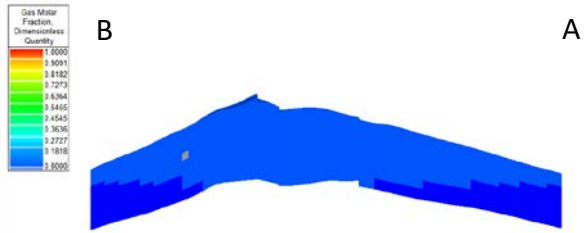
Net to Gross ratio for Brown Dolomite L-01



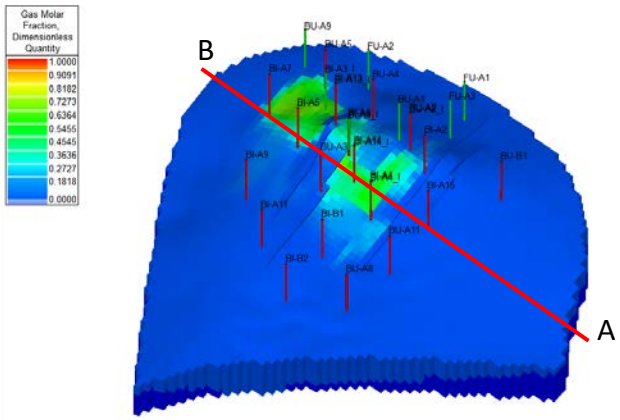
porosity changes for Brown Dolomite L-01

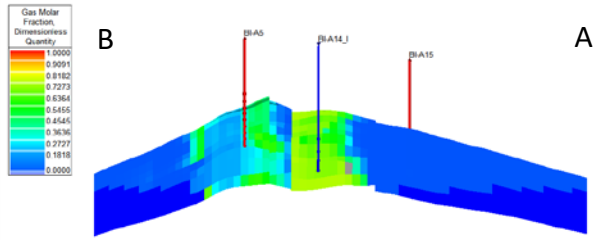
CURRENT RESERVOIR CONDITIONS AT BUSH DOME

Helium Mole Fraction Distribution. Cross Section Analysis- Brown Dolomite (X-section AB)

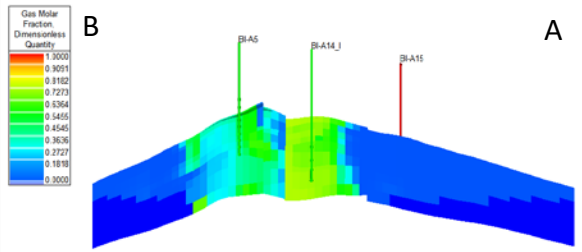


a. HE mole Fraction Cross Section . Dec-40

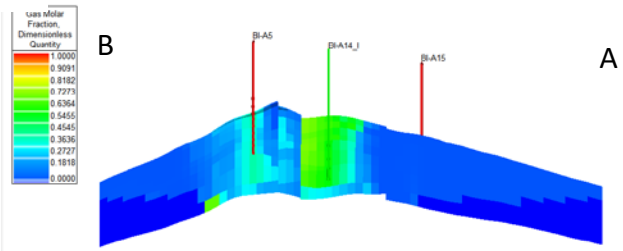




b. HE mole Fraction Cross Section. Dec-73

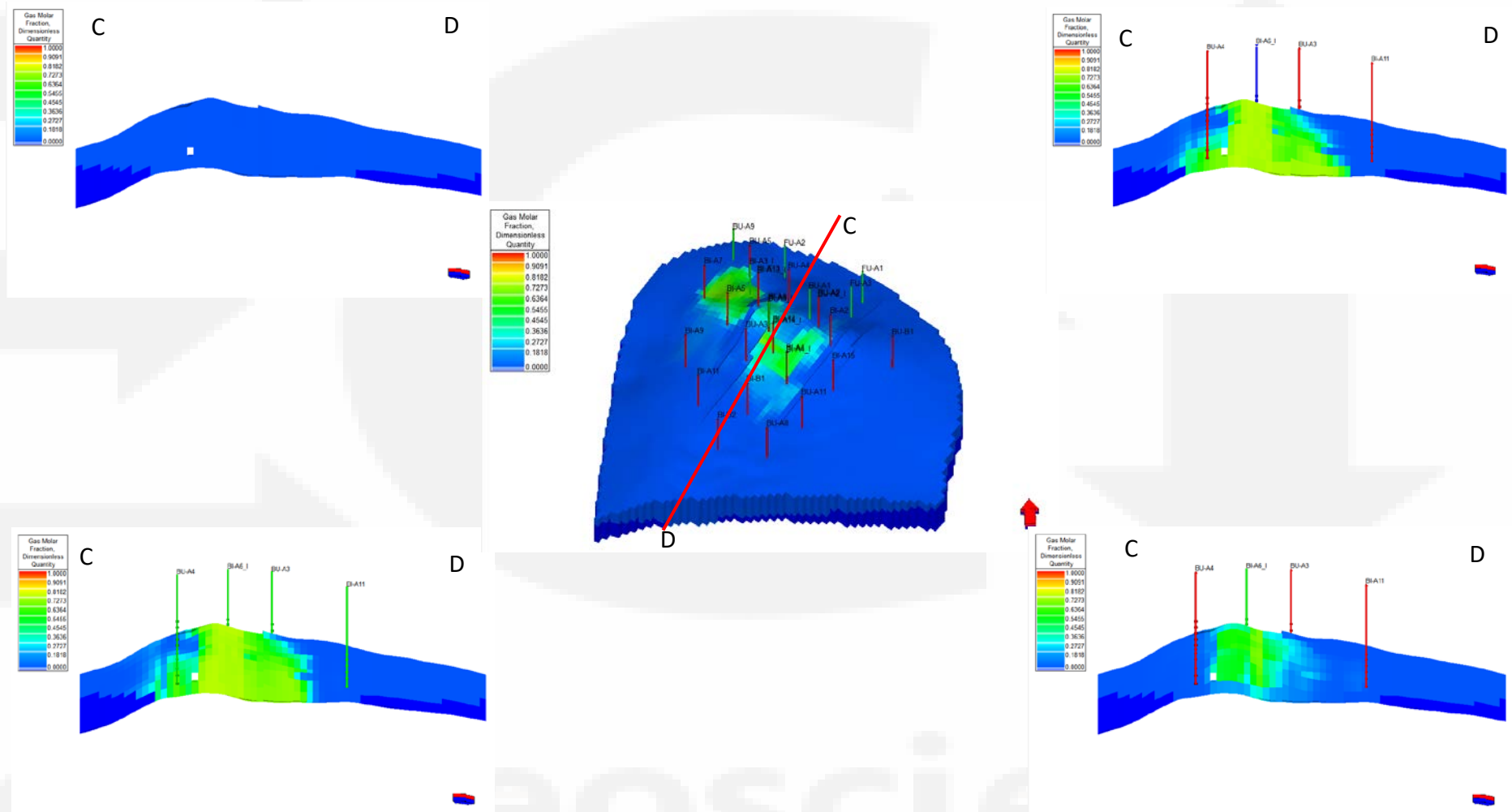


c. HE mole Fraction Cross Section . Dec-83

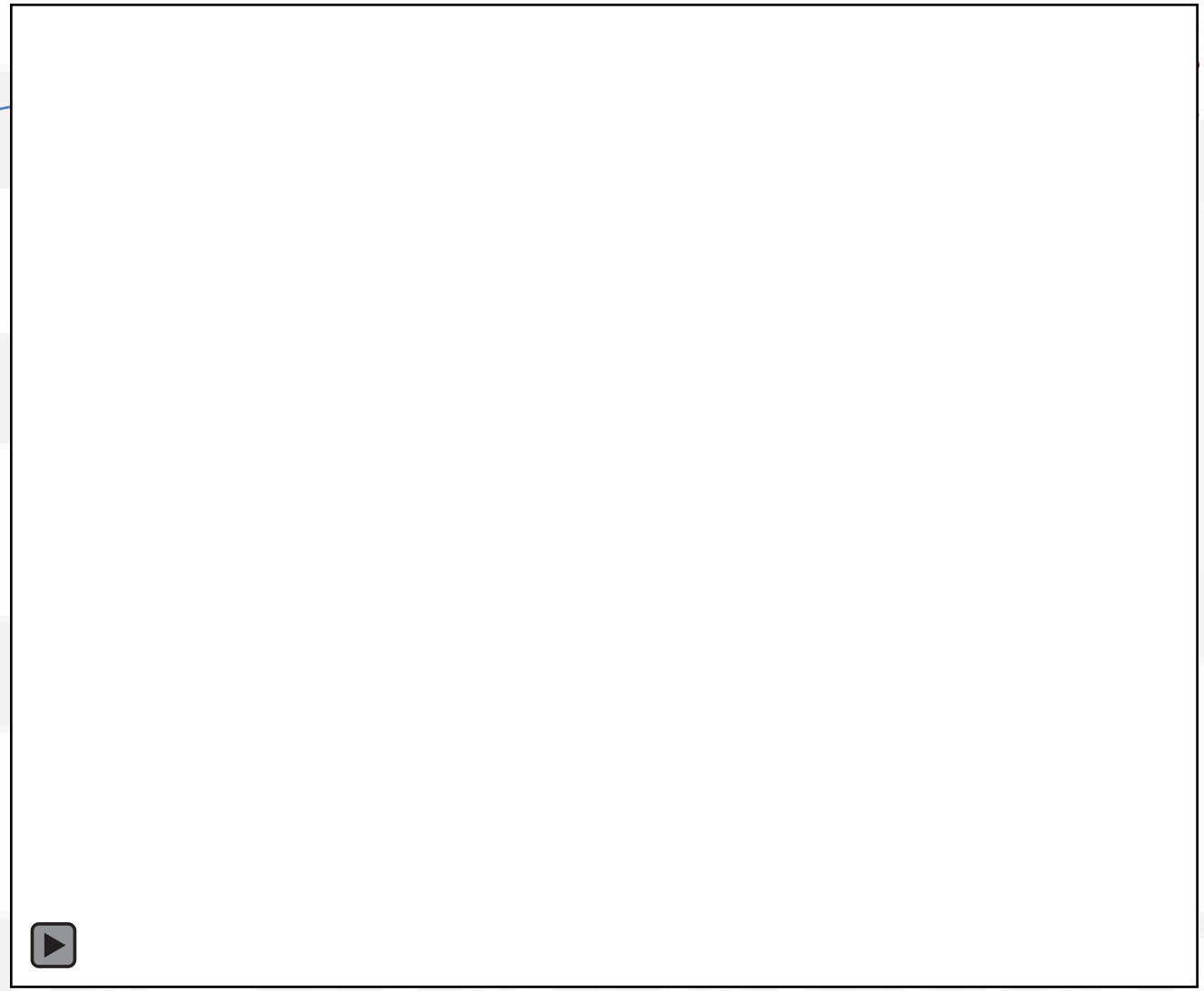


d. HE mole Fraction Cross Section . Dec-18

Helium Mole Fraction Distribution. Cross Section Analysis-Brown Dolomite (X-section CD)

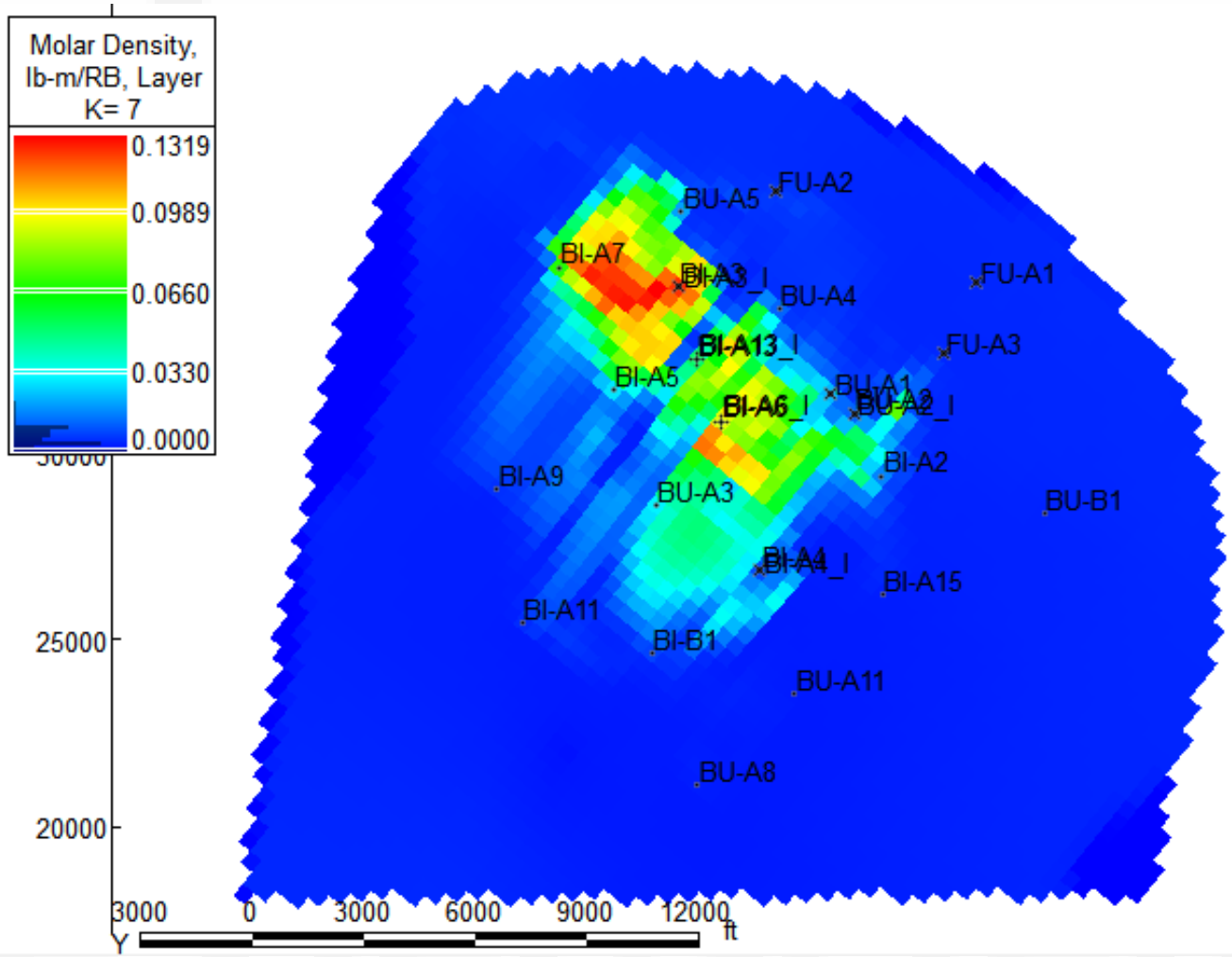


Latest Reservoir Simulation Model



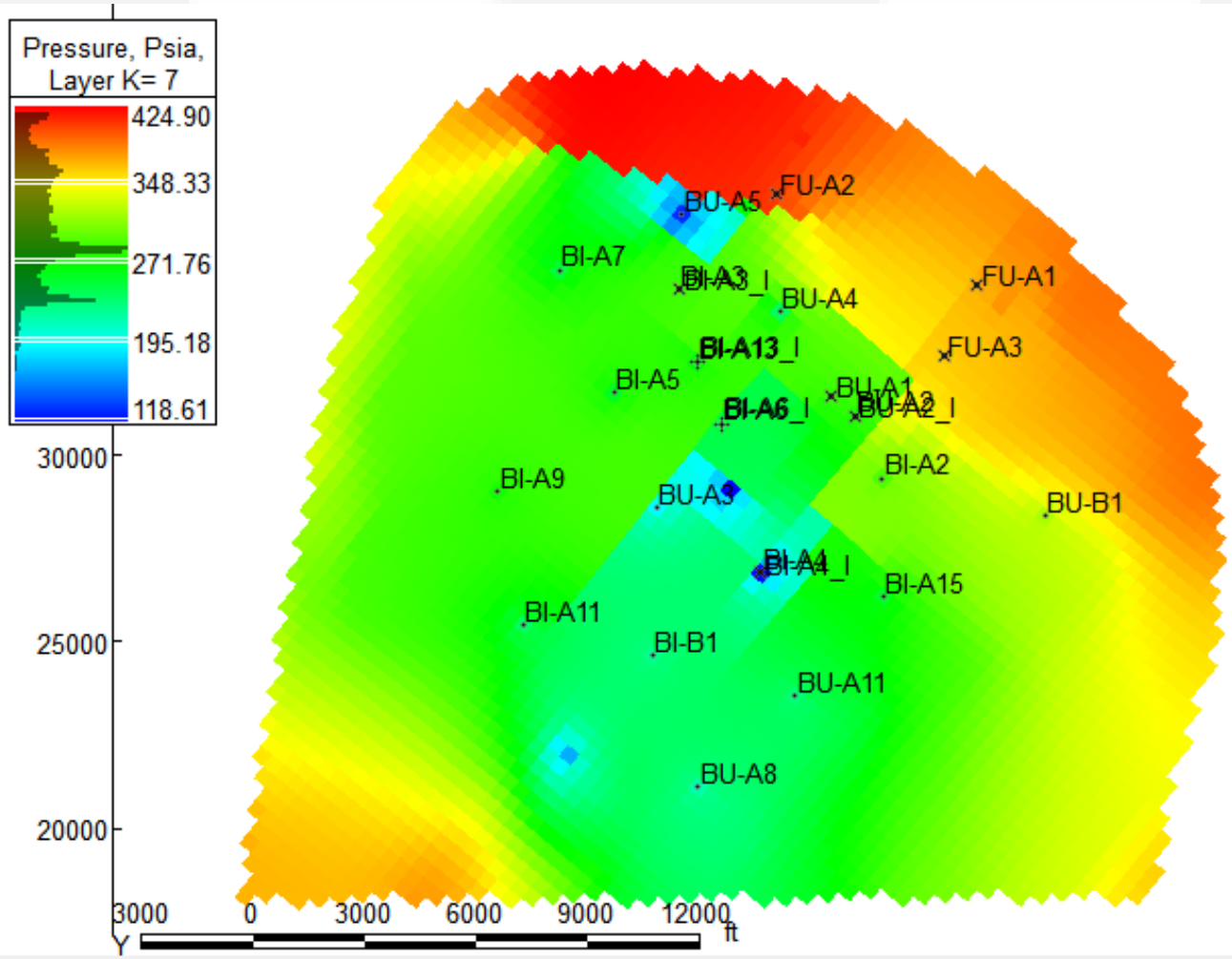
The video shows helium mole fraction changes at the middle of Brown Dolomite from 1 July 2019 through 1 August 2021

Helium Mole Fraction at BD-4 (Middle of Brown Dolomite)

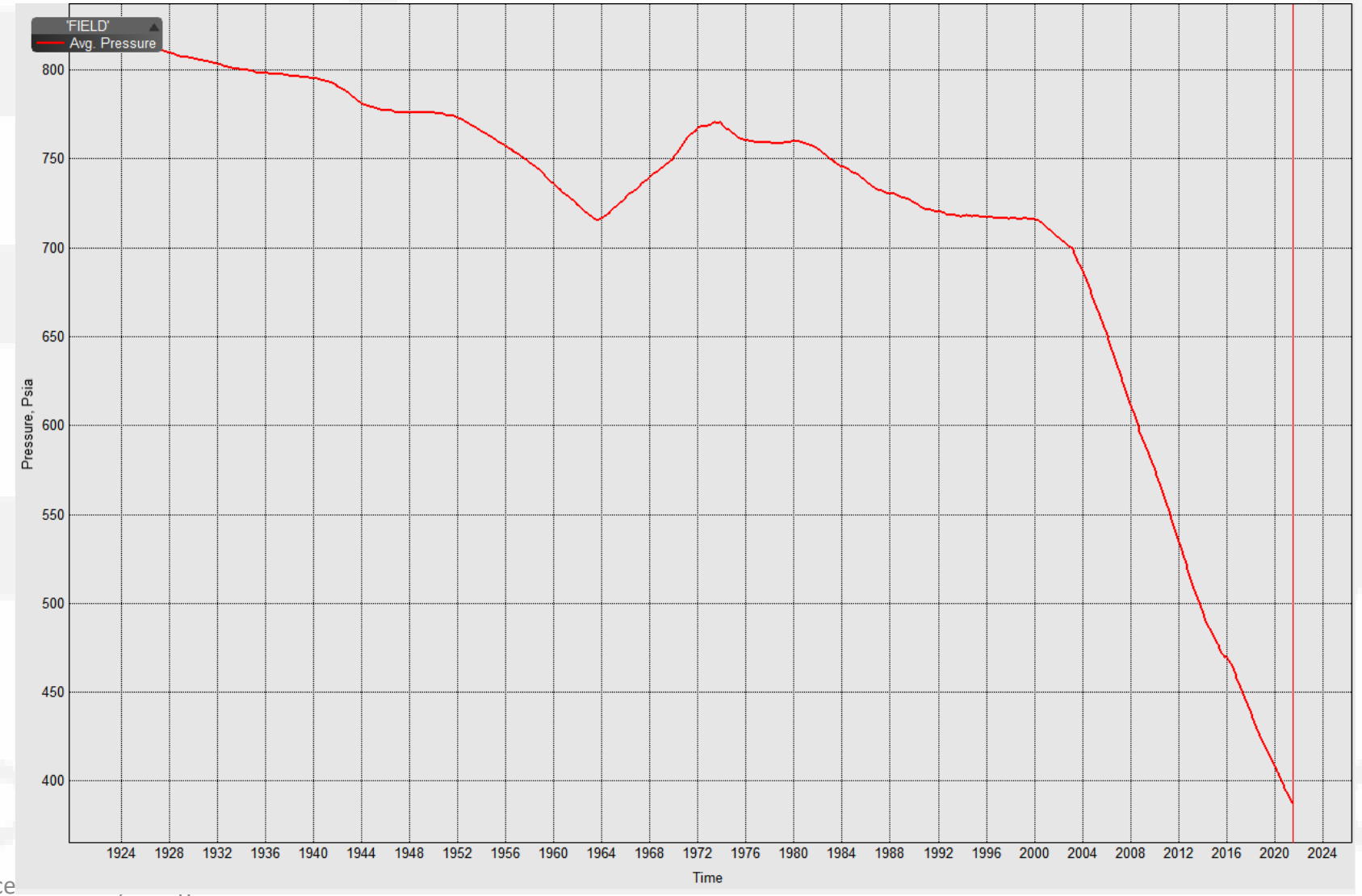


At the end of 2020

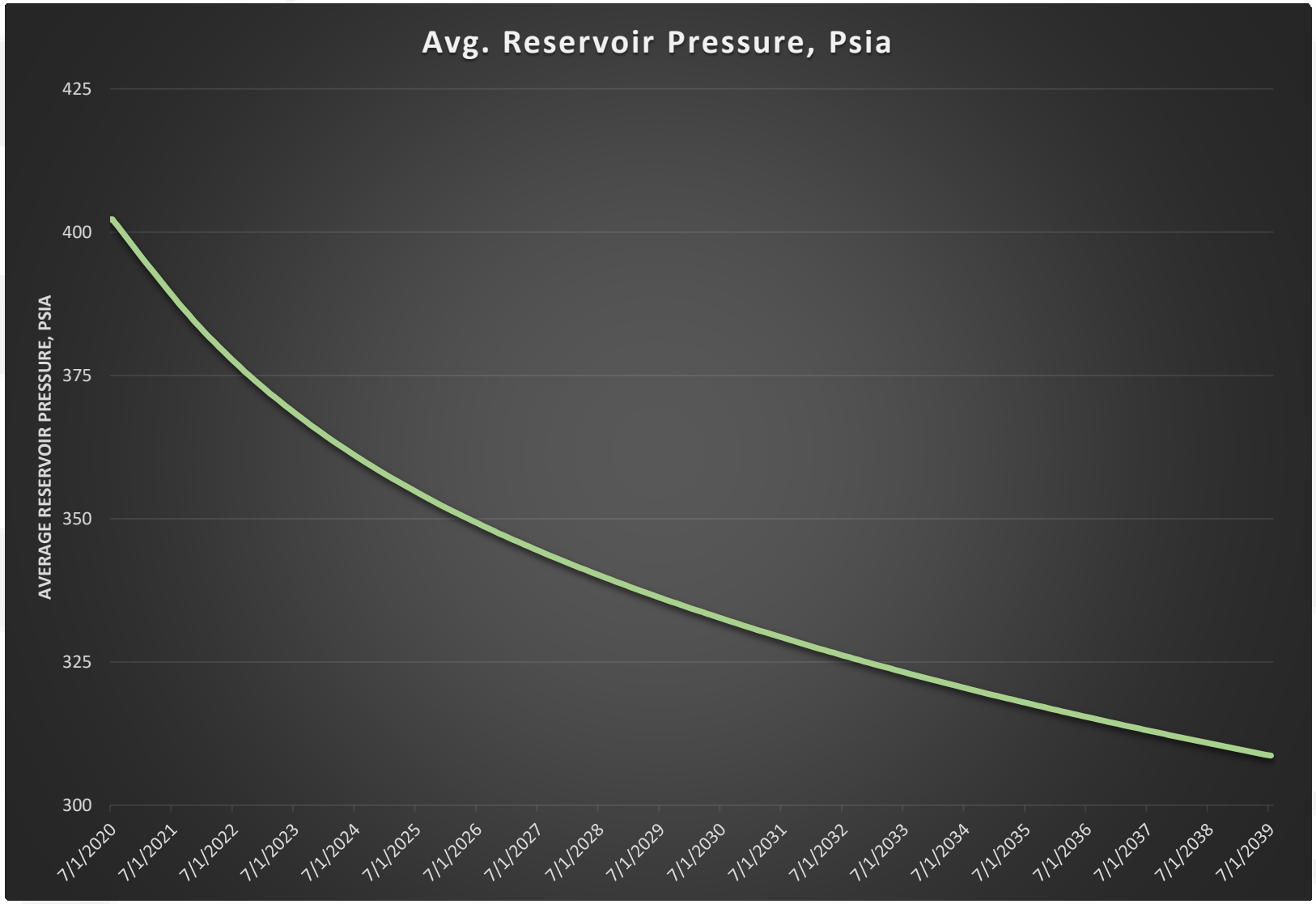
Reservoir Pressure at BD-4 (Middle of Brown Dolomite)



Latest Estimates of the Average Reservoir Pressure, psi



Average Reservoir Pressure Forecast, psi



RESULTS OF THE PRESSURE TRANSIENT ANALYSIS

Bush Dome Forecast

Well Stimulation

Skin Factor is a dimensionless factor that can help understand the severity of formation damage (and thus, pressure loss) near the wellbore

Results of our analyses show that a well stimulation job can increase the production from the wells in short time before October 2021.

The results of the Pressure Transient Analysis indicate fractured reservoir with intersecting faults, dual porosity rock. PTA analysis indicated minimal porosity change over time but slight permeability change and medium skin damage.

Derivative Log shape's similarity to Rectangle Reservoir (Fault in the boundary)

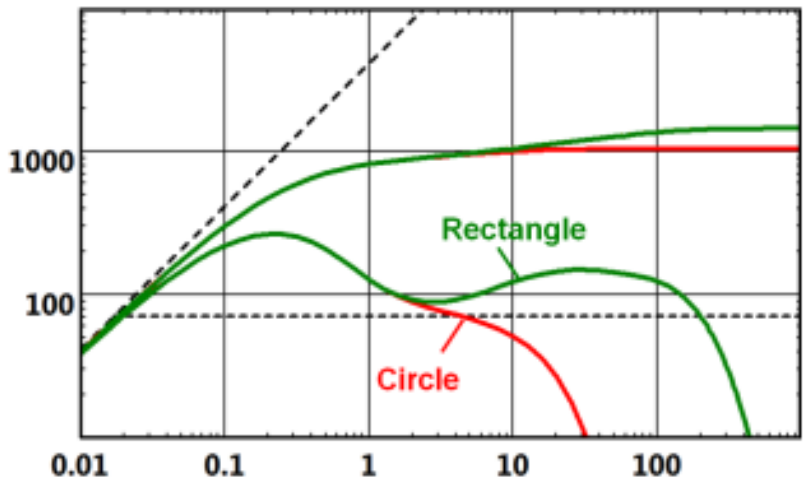
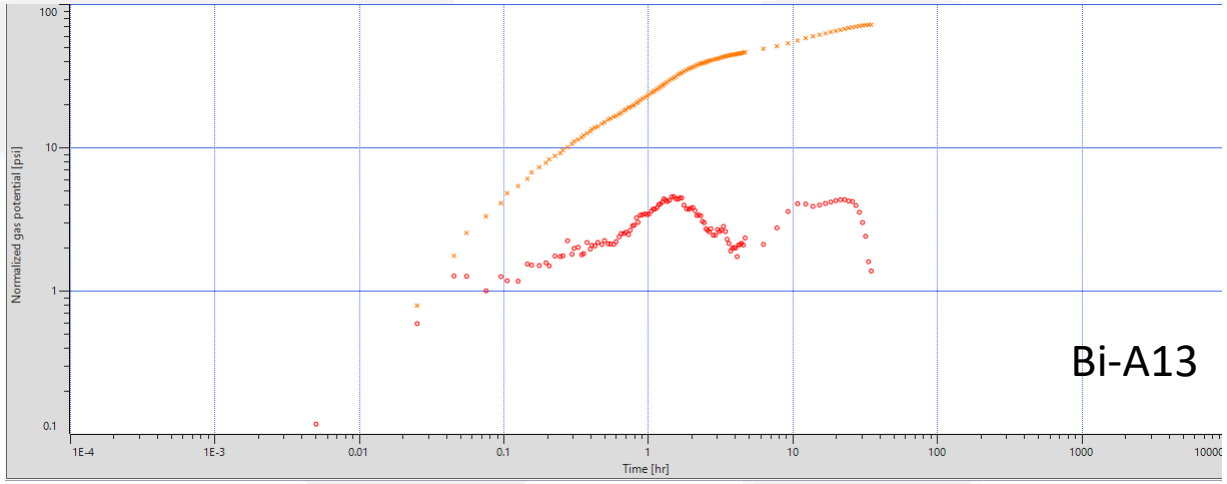
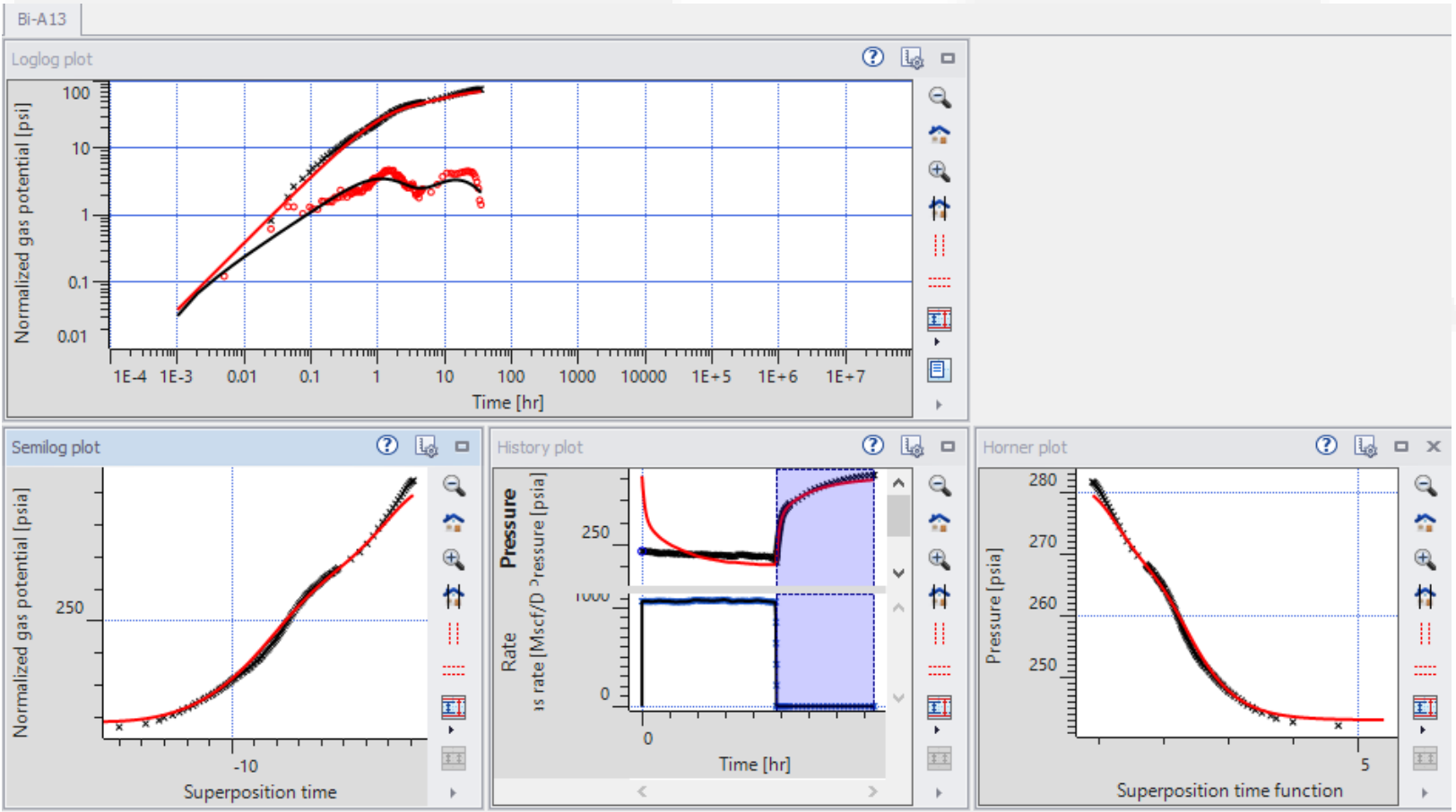


Fig. 8.F.6 – Circle and Rectangle solutions Shut-in period, loglog plot



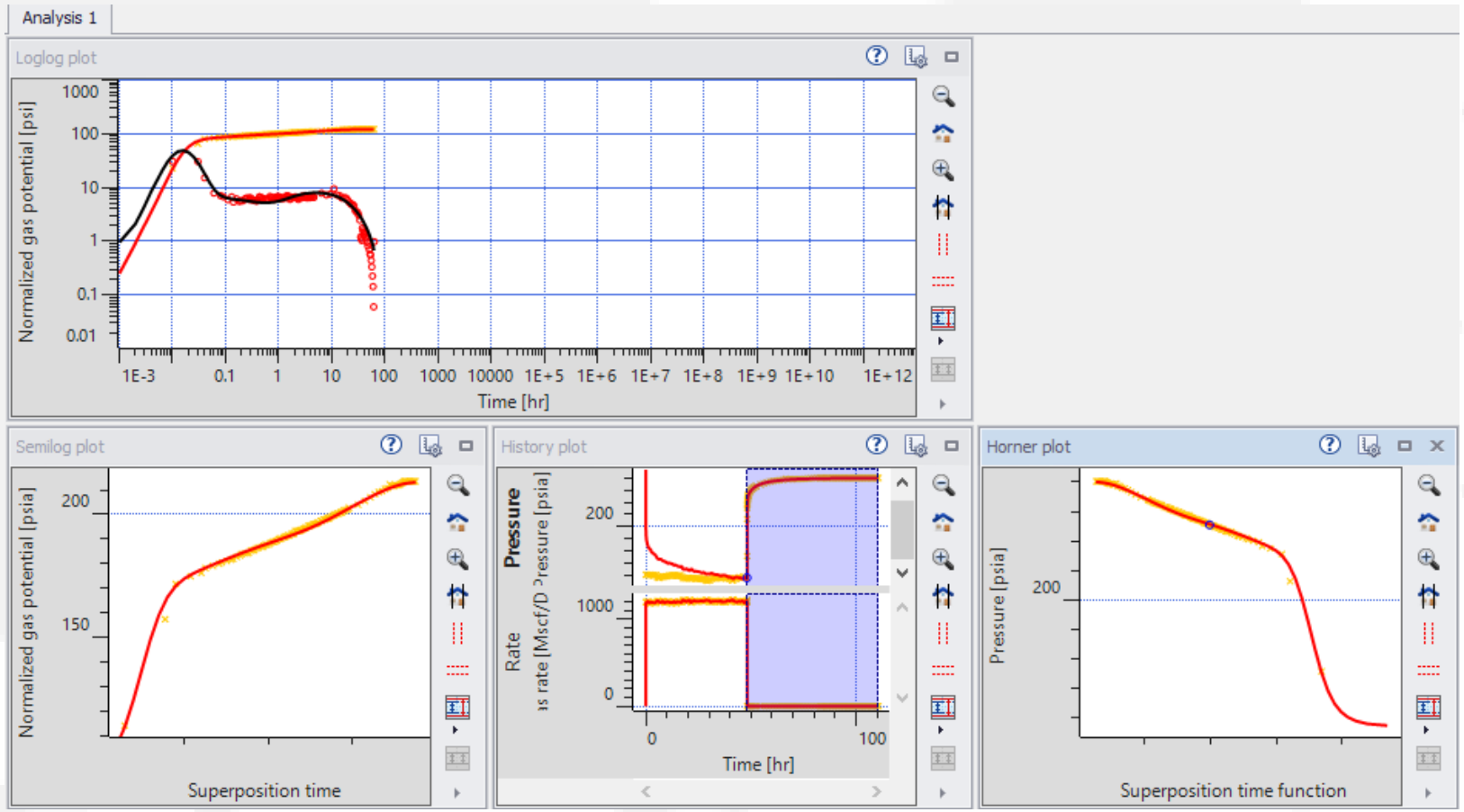
Results of Pressure Transient Analysis (Bi-A13)



Conclusion from PTA analysis for Bi-A13:

- Dual Porosity Transient reservoir
- Rectangular boundary shape (could mean intersecting sealing faults)
- Permeability reduction but no major porosity change (strong rock matrix and flow through natural fractures)
  - ✓ Permeability: 21.7 mD to 19.3 mD
  - ✓ Porosity: 11% to ~11% unchanged
- High vertical rock anisotropy

Results of Pressure Transient Analysis (Bi-A14)



Conclusion from PTA analysis for Bi-A14:

- Dual Porosity Transient reservoir
- Rectangular boundary shape (could mean intersecting sealing faults).
- The well has proximity to major faults or discontinuity planes.
- Permeability reduction but no major porosity change (strong rock matrix and flow through natural fractures)
  - ✓ Permeability: 26 mD to 8 mD
  - ✓ Porosity: 11% to ~9 %
- High vertical rock anisotropy

WELLS' PRIORITIES FOR POSSIBLE ACIDIZING OPERATION

Prioritization for Acidizing

Factors Considered:

1- Annual Cumulative Helium Production
2- Annual Cumulative Gas Production
3- Results of PTA
4- Results of Reservoir Simulations

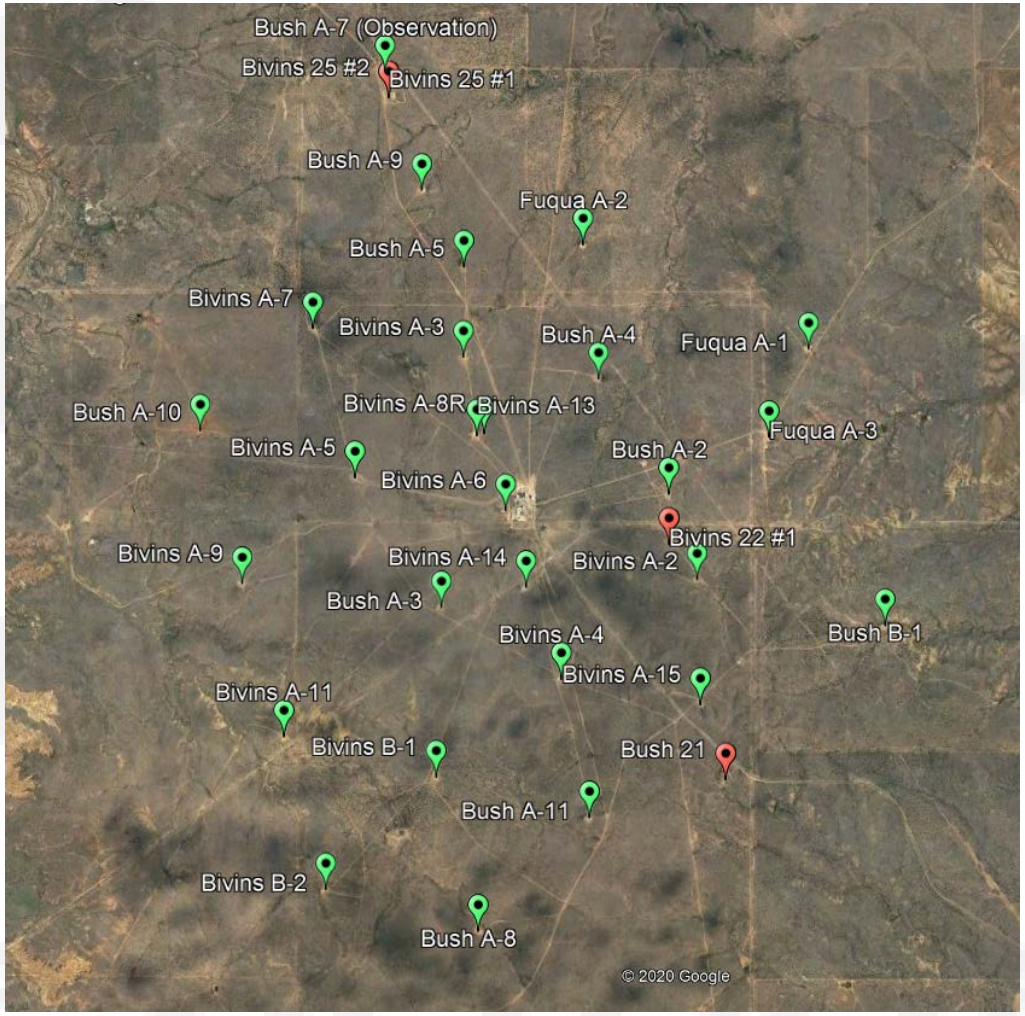
Wells are categorized into three groups (Green, Yellow and Orange)

Well Name	Acidizing Preference Group
Bi-A6	1
Bi-A13	1
Bu-A5	1
Bi-A7	1
Bi-A14	1
Bu-A3	1
Bi-A5	1
Bi-A4	1
Bi-A2	1
Bu-A4	2
Bi-A9	2
Bi-B1	2
Bi-A11	2
Bi-B2	2
Bu-A2	2
Bi-A15	Not Recommended
Bu-A11	Not Recommended
Bu-A8	Not Recommended
Bu-B1	Not Recommended

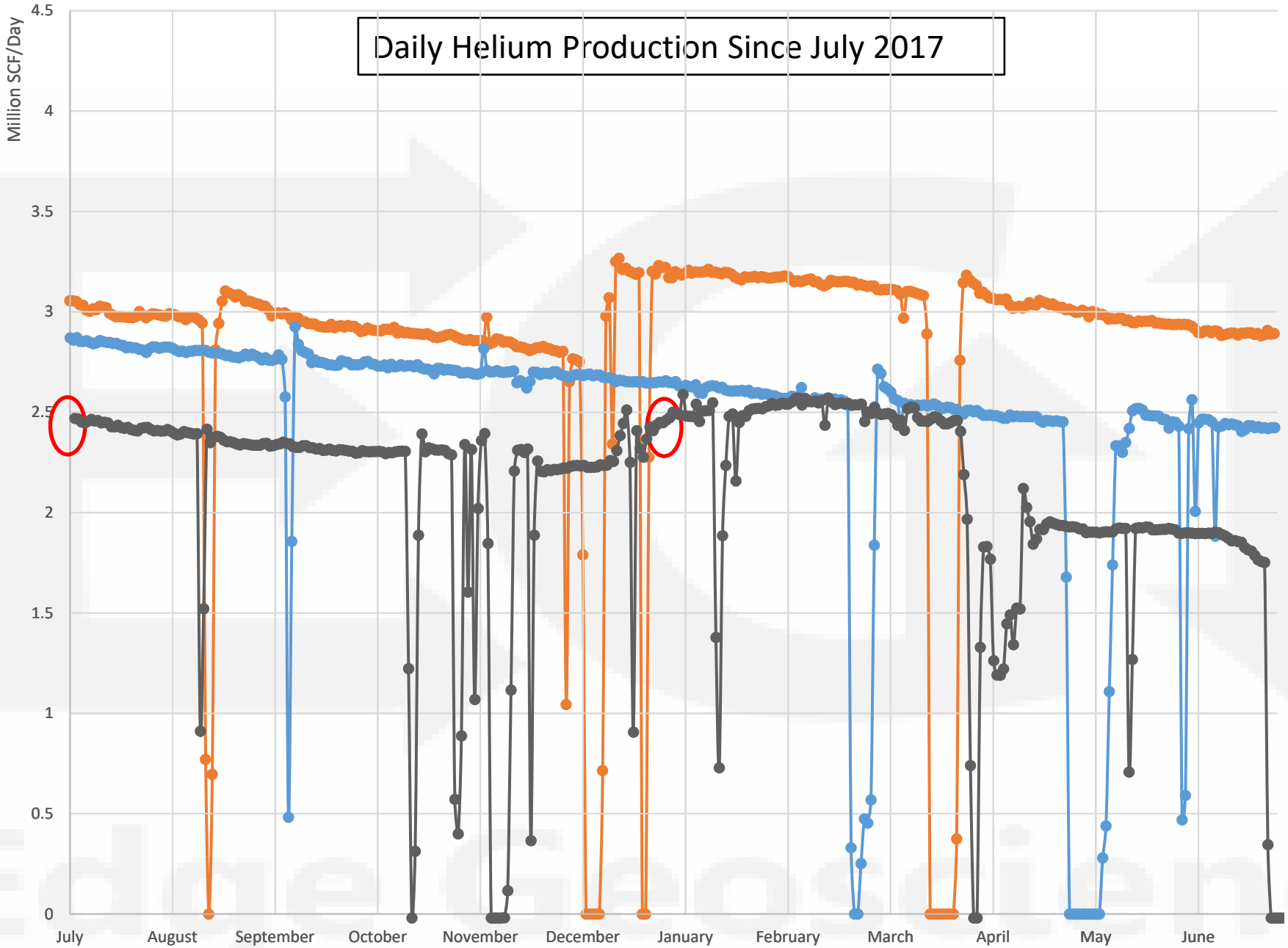
The target is to maximize helium production
Wells are categorized into high, medium and low Helium production groups
Budget Limitation → Acidize Green Group
Available Budget → Acidize yellow, observe feedback → Acidize Green

REVIEW OF RESERVOIR'S PRODUCTION PERFORMANCE

Wells and Plant Location on Google Earth



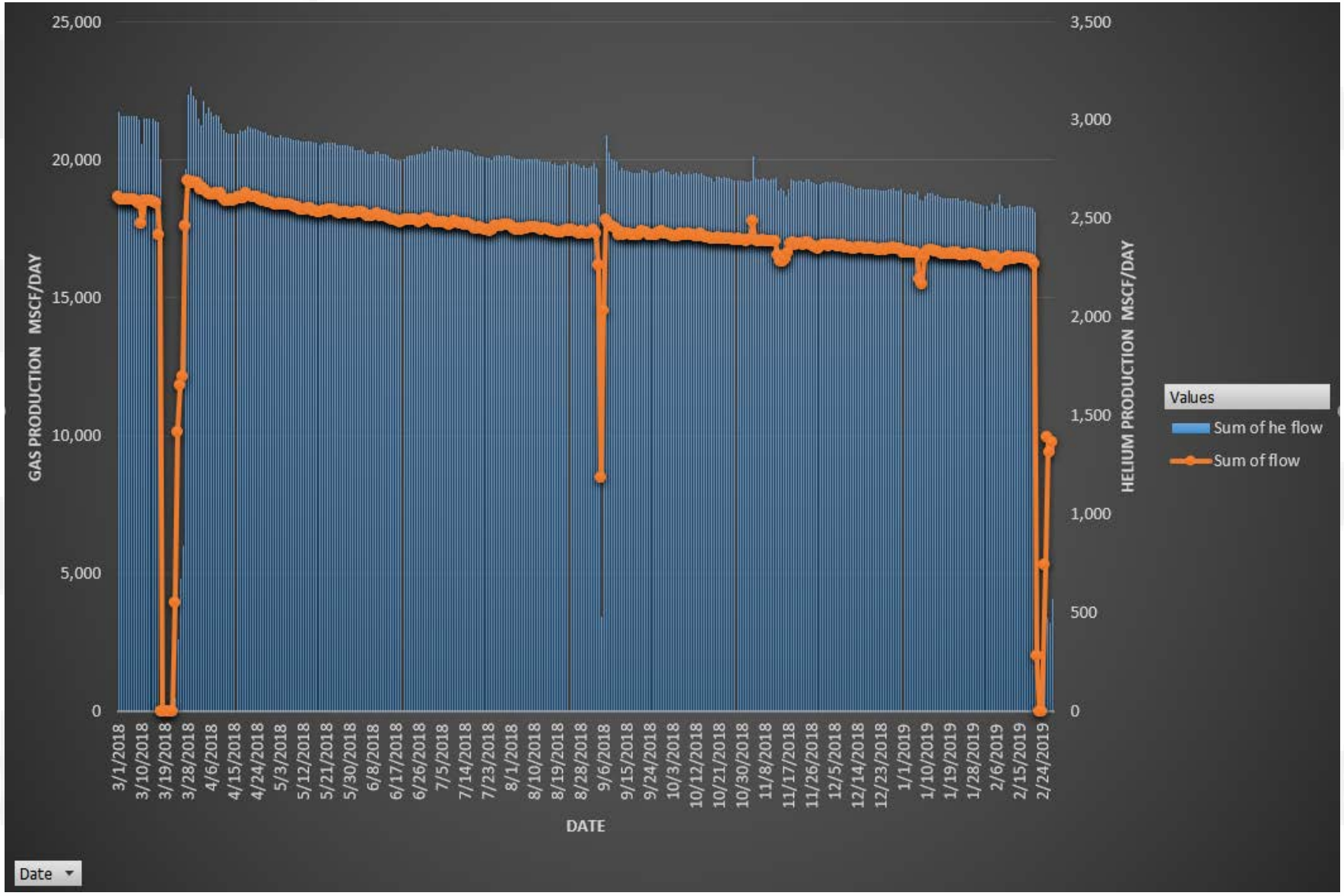
Edge Geoscience Inc.



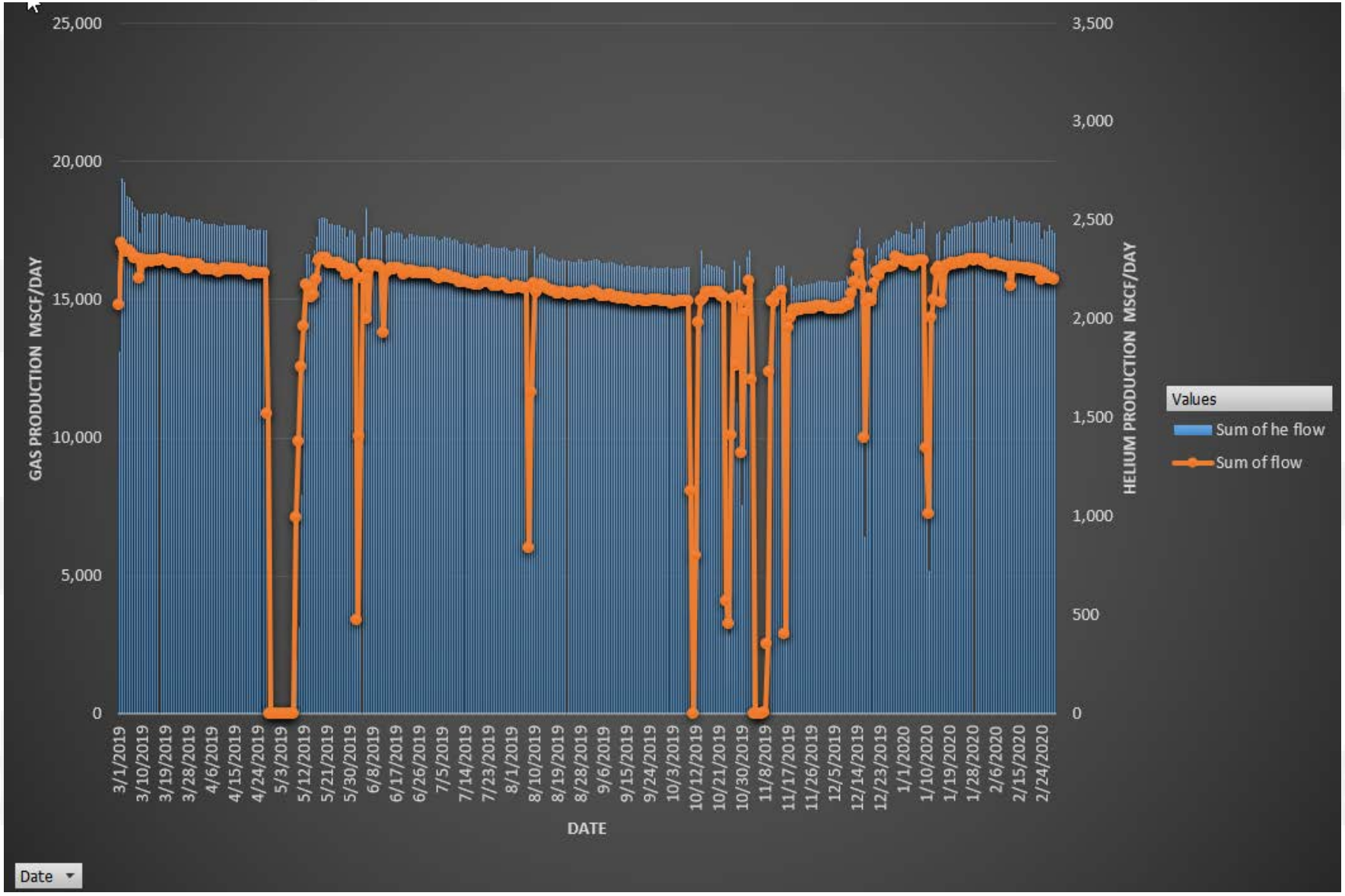
2017-18 Cal. Year
2018-19 Cal. Year
2019-20 Cal. Year

- Major reduction in daily Helium production rates YoY
- Lesser impact of artificial lift on production enhancement by time
- With the artificial lift, the daily production rates have raised to rates of nearly 6 months ago

March 2018-March 2019 Total Gas and Helium Flow Rates per Day



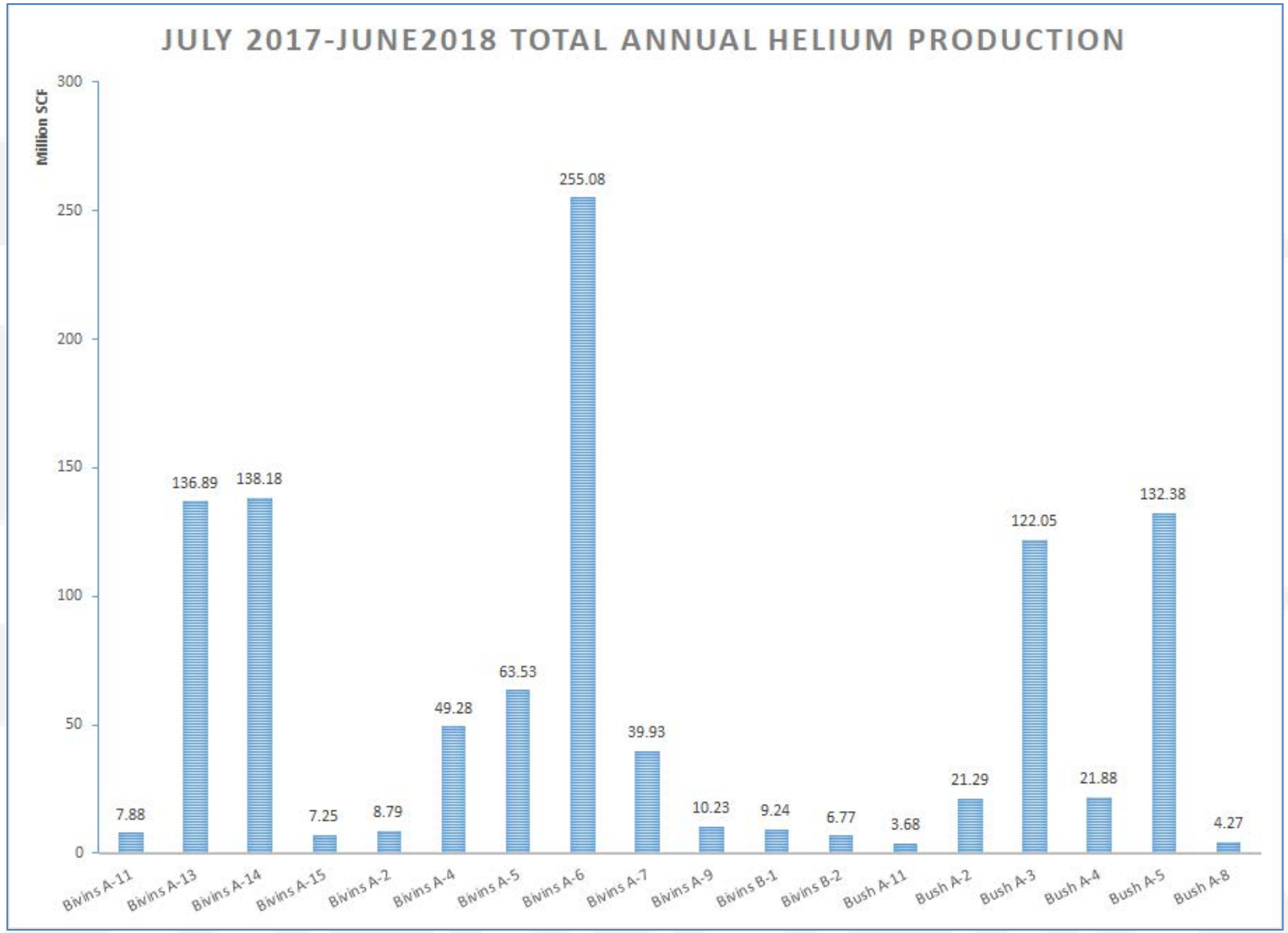
March 2019-March 2020 Total Gas and Helium Flow Rates per Day

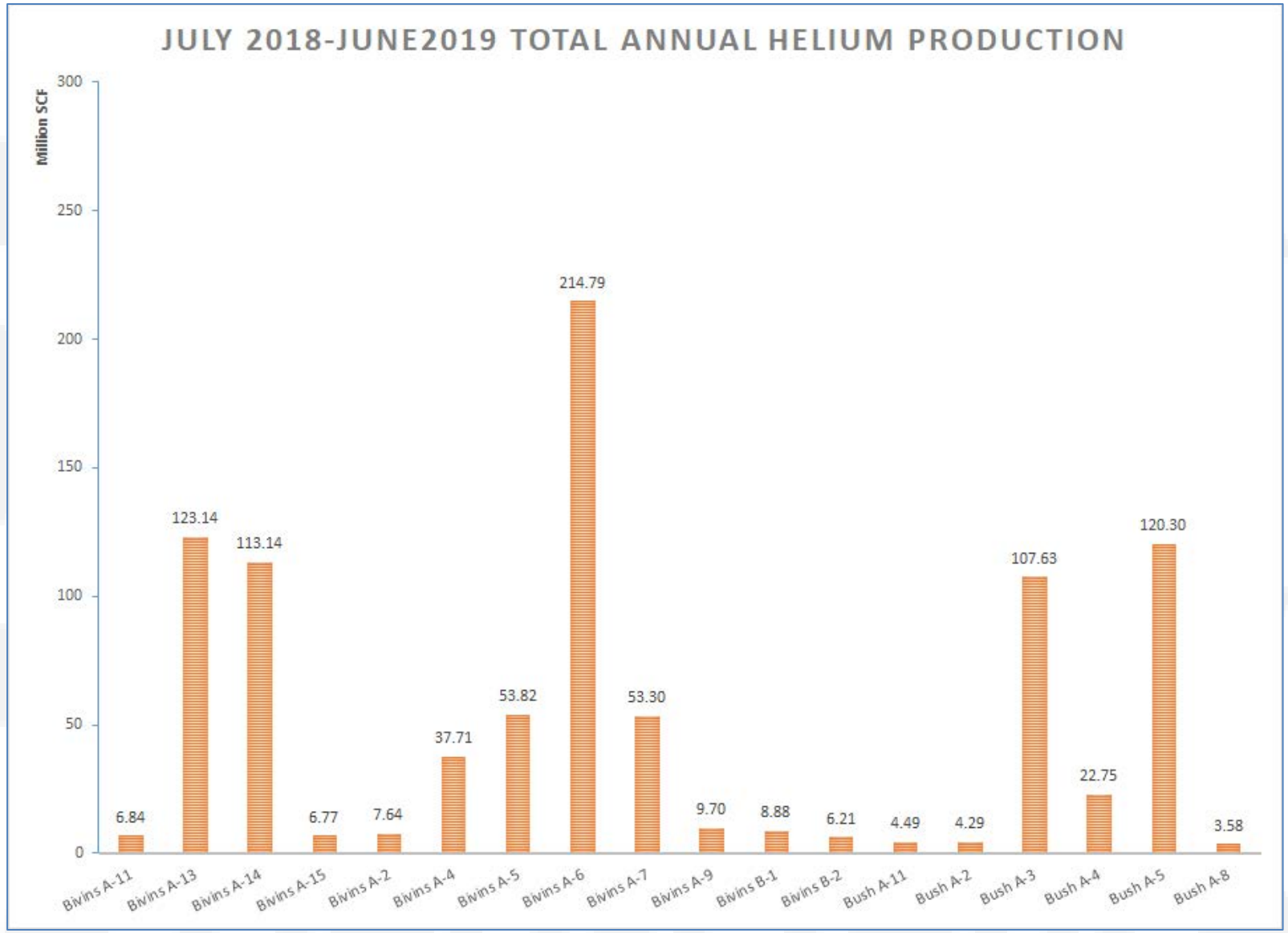


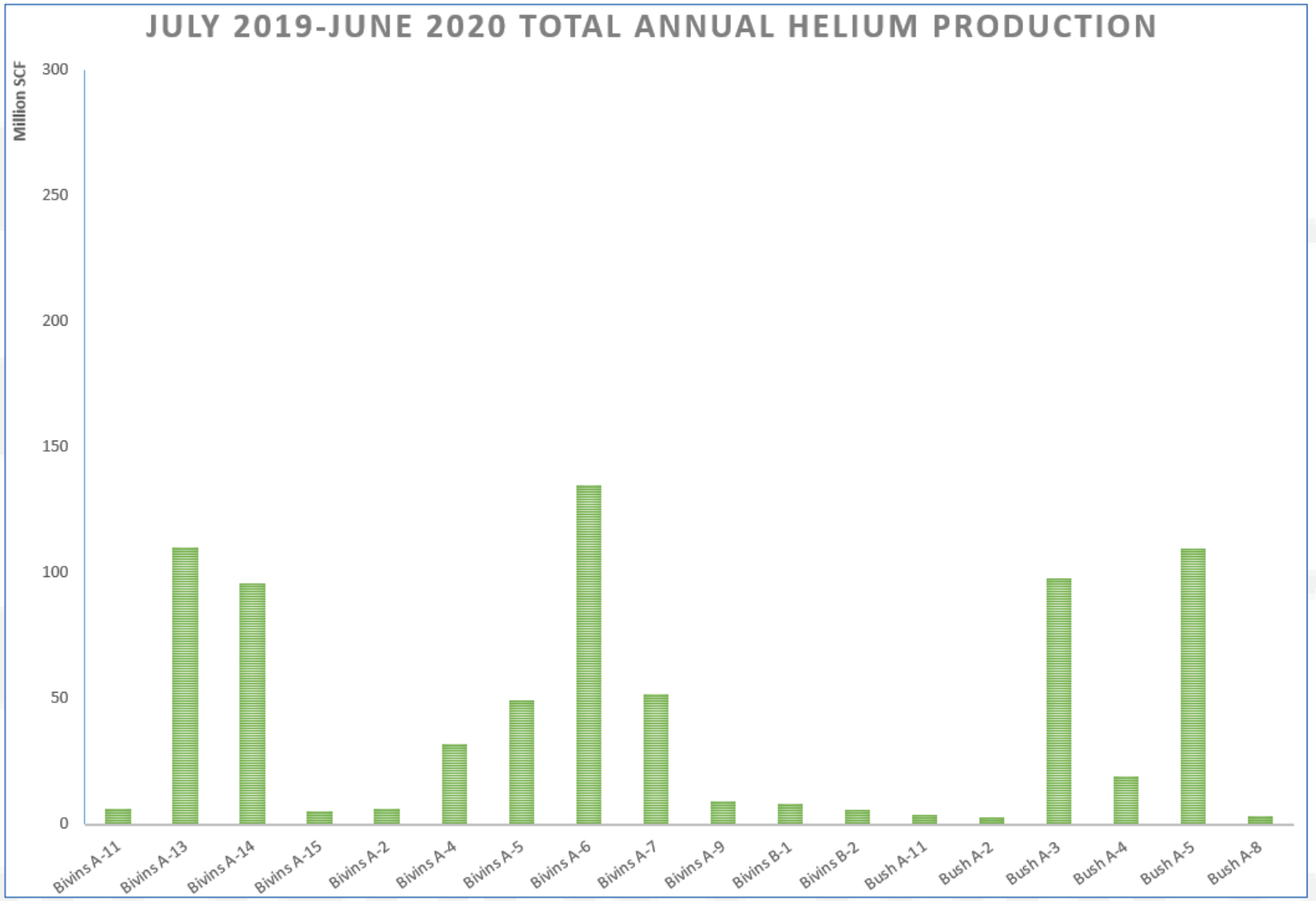
YoY Helium and Gas Production Comparison

Net Production (BCF)	July 2018-July 2019	July 2019-July 2020	Change year over year
Net Gas	5.823	5.048	-13.3%
Net Helium	0.906	0.627	-30.79%

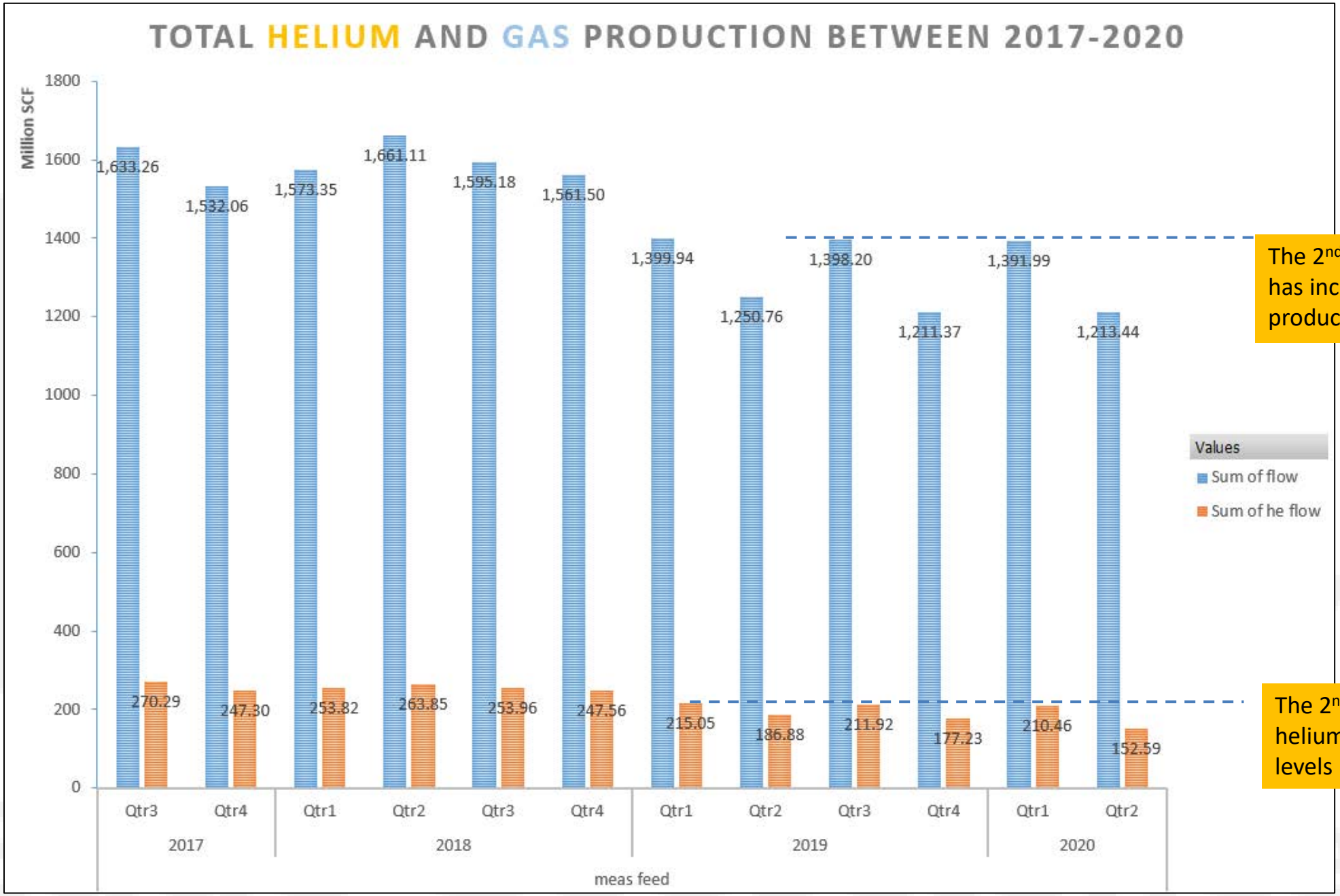
Part of the quick decline in YoY NET gas and helium production decline is due to crude helium reinjection to the reservoir, starting in late March 2020.







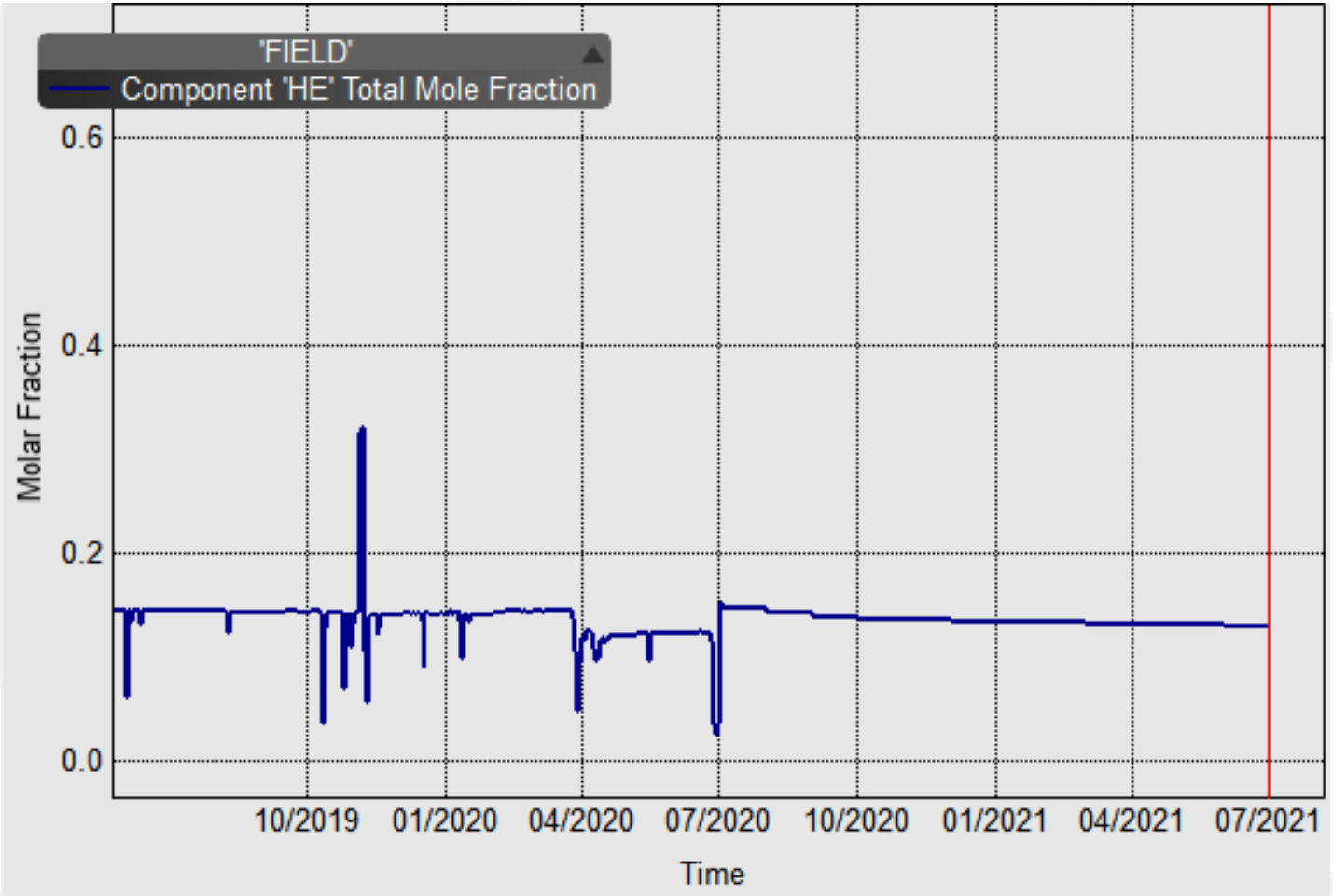
TOTAL HELIUM AND GAS PRODUCTION BETWEEN 2017-2020



The 2nd compressor installation has increased total gas production to 1st Qr 2019 levels

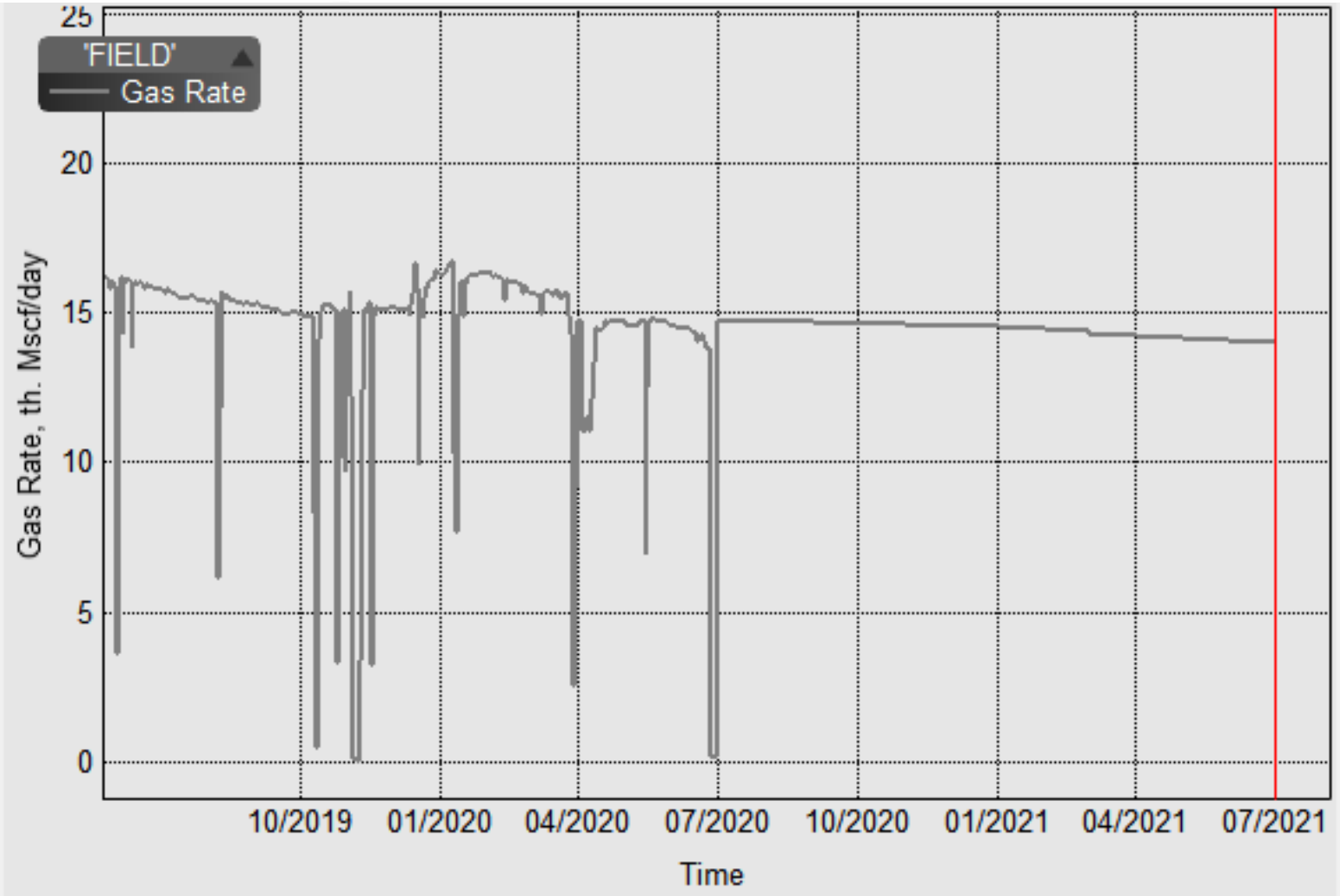
The 2nd compressor has increased helium production to 1st Qr 2019 levels

The Average Ratio of Helium Production to Total Gas Production (Ave. Helium Content, fraction)

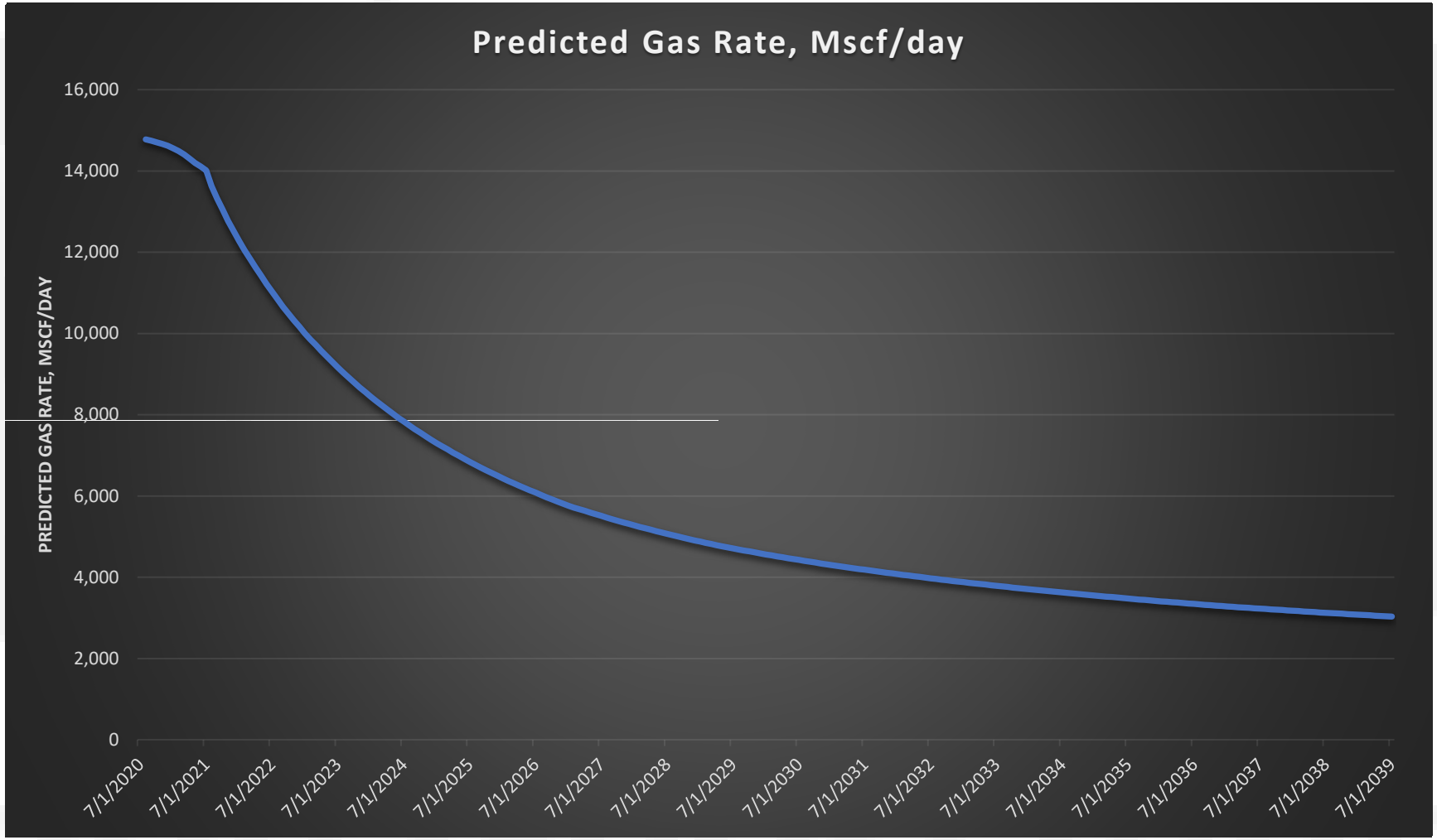


Major jump in helium fraction was witnessed in November 2019 which was caused due to reservoir turbulence after new compressor setup. But in average the helium mole fraction stands between 13-14%.

Total Gas Rates and the Forecast until 2021



Total Gas Rates Forecast until 2039



2019-20 FY STATISTICAL RESULTS AND THEIR COMPARISON WITH PAST YEARS

Comparison of Annual Cumulative Gas Production with Previous Years

Well Name	2019-20 Gas Production (MMSCF)	2018-19 Gas Production (MMSCF)	2017-18 Gas Production (MMSCF)	YoY change,% (18-19) & (19-20)	YoY change,% (17-18) & (18-19)
Bivins A-6	379.81	549.45	587.93	-30.9	-6.55
Bush A-5	468.9	492.57	516.36	-4.8	-4.61
Bivins A-14	432.84	444.72	490.51	-2.7	-9.34
Bivins A-15	330.62	399.7	422.78	-17.3	-5.46
Bivins A-13	369.3	392.08	421.92	-5.8	-7.07
Bivins B-1	351.85	378.75	397.13	-7.1	-4.63
Bivins A-4	348.38	374.45	448.51	-7.0	-16.51
Bivins A-9	305.01	347.16	396.29	-12.1	-12.4
Bush A-3	310.5	343.48	374	-9.6	-8.16
Bivins B-2	306.66	330.42	362.79	-7.2	-8.92
Bivins A-5	279.9	301.95	344.93	-7.3	-12.46
Bush A-4	264.08	273.84	250.51	-3.6	9.31
Bivins A-2	207.66	235.42	255.26	-11.8	-7.77
Bivins A-11	208.23	229.79	269.24	-9.4	-14.65
Bush A-11	187.38	204.93	168.03	-8.6	21.96
Bush A-8	181.79	197.36	233.63	-7.9	-15.53
Bivins A-7	173	179.68	139	-3.7	29.26
Bush A-2	64.7	96.85	295.22	-33.2	-67.19
Bush B-1	62.23	51.24	51.65	21.4	-0.78
Bivins A-3	0	0	0		
Bush A-9	0	0	0		
Fuqua A-1	0	0	0		
Fuqua A-3	0	0	0		
Bush Dome	**5215**	**5823.82**	**6425.71**	**-9**	**-9.37**

- Top 8 wells contribute in ~60% of Gas Production
- The annual gas production in these 8 wells has declined ~11% year over year (YoY).
- In reservoir scale, annual gas production has decreased from 5.82 BCF to 5.21 (YoY)
- This shows a ~10.5% year over year decline

Comparison of Annual Helium Production with Previous Years

Well Name	2019-20 He Production (MMSCF)	2018-19 He Production (MMSCF)	2017-18 He Production (MMSCF)	YoY change,% (18-19) & (19-20)	YoY change,% (17-18) & (18-19)
Bivins A-6	135.05	214.79	255.08	-37.12	-15.79
Bivins A-13	110.023	123.14	136.89	-10.65	-10.05
Bush A-5	109.54	120.3	132.38	-8.94	-9.13
Bivins A-14	95.65	113.14	138.18	-15.46	-18.12
Bush A-3	98.102	107.63	122.05	-8.85	-11.82
Bivins A-5	49.305	53.82	63.53	-8.39	-15.29
Bivins A-7	52.08	53.3	39.93	-2.29	33.48
Bivins A-4	32.1	37.71	49.28	-14.88	-23.49
Bush A-4	19.06	22.75	21.88	-16.22	3.97
Bivins A-9	9.09	9.7	10.23	-6.29	-5.16
Bivins B-1	8.12	8.88	9.24	-8.56	-3.98
Bivins A-2	6.375	7.64	8.79	-16.56	-13.09
Bivins A-11	6.22	6.84	7.88	-9.06	-13.21
Bivins A-15	5.5	6.77	7.25	-18.76	-6.71
Bivins B-2	5.65	6.21	6.77	-9.02	-8.26
Bush A-11	4.08	4.49	3.68	-9.13	22.17
Bush A-2	2.77	4.29	21.29	-35.43	-79.86
Bush A-8	3.28	3.58	4.27	-8.38	-15.97
Bush B-1	1.07	0.89	0.9	20.22	-1.41
Bivins A-3	0	0	0		
Bush A-9	0	0	0		0
Fuqua A-1	0	0	0		0
Fuqua A-3	0	0	0		0
Bush Dome	**752**	**905.85**	**1039.5**	**-11.78**	**-12.86**

- The cumulative helium production between July 2019-June2020 was 0.752 BCF (Compared to ~0.905 BCF the year before)
- Top 8 wells contribute in ~90% of Helium Production
- The annual Helium production in top 8 wells has declined ~13.3?% year over year (YoY).

Comparison of Annual Helium Production with Past 2 Years

Top Helium Producers			
Rank	**2019-20 year**	**2018-19 year**	**2017-18 year**
1	BI-A6	BI-A6	BI-A6
2	BI-A13	BI-A13	BI-A14
3	BU-A5	BU-A5	BI-A13
4	BU-A3	BI-A14	BU-A5
5	BI-A14	BU-A3	BU-A3
6	BI-A7	BI-A5	BI-A5
7	BI-A5	BI-A7	BI-A4
8	BI-A4	BI-A4	BI-A7

- Top 8 wells contribute in ~90% of Helium Production.
- Bi-A6 is still the biggest Helium Producer

- Compared to last year, the wells' ranking has changed slightly but overall, they are still the top 8 Helium producers and still contribute in 90% of He production.

(Average Wellhead Pressure (WHP) changes in the past 11 years)

Beginning from July of	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
Ending on July of	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	**2020**
Beginning WHP (psi)	362	334	310	278	287	277	255	232	197	158	**133**
Ending WHP (psi)	334	303	278	251	277	255	232	197	158	133	**94**
Change,%	-7.7	-9.3	-10.3	-9.7	-3.5	-7.9	-9.0	-15.1	-19.8	-15.8	**-29.3**

- WHP has been on a continuous decline in the past 11 years
- The WHP decline has been accelerated in the past few years with this year as the highest in 10 years.
- This rapid WHP is due to the installation of the new compressor.

(Helium Production changes in the past 11 years)

Beginning from July of	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
Ending on July of	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	**2020**
Helium Production (BCF)	1.817	2.123	2.263	1.97	1.428	0.916	0.751	1.059	1.042	0.906	**0.755**
Helium Injection (BCF)	-0.163	0	0	0	-0.015	-0.06	-0.074	-0.007	0	0	**-0.128**
Net Helium Production (BCF)	1.654	2.123	2.263	1.970	1.413	0.856	0.677	1.052	1.042	0.906	**0.627**
Year over Year Change,%		28.36	6.59	-12.95	-28.27	-39.42	-20.91	55.39	-0.95	-13.05	**-30.79**

The **total** Helium production in 2019-20 has decreased from 0.906 to 0.755 BCF, showing 16.67% YoY decline.

Due to the helium re-injection, **NET** Helium production in 2019-20 has decreased from 0.906 to 0.627 BCF, showing 30.79% YoY decline.

(Total Gas Production changes in the past 11 years)

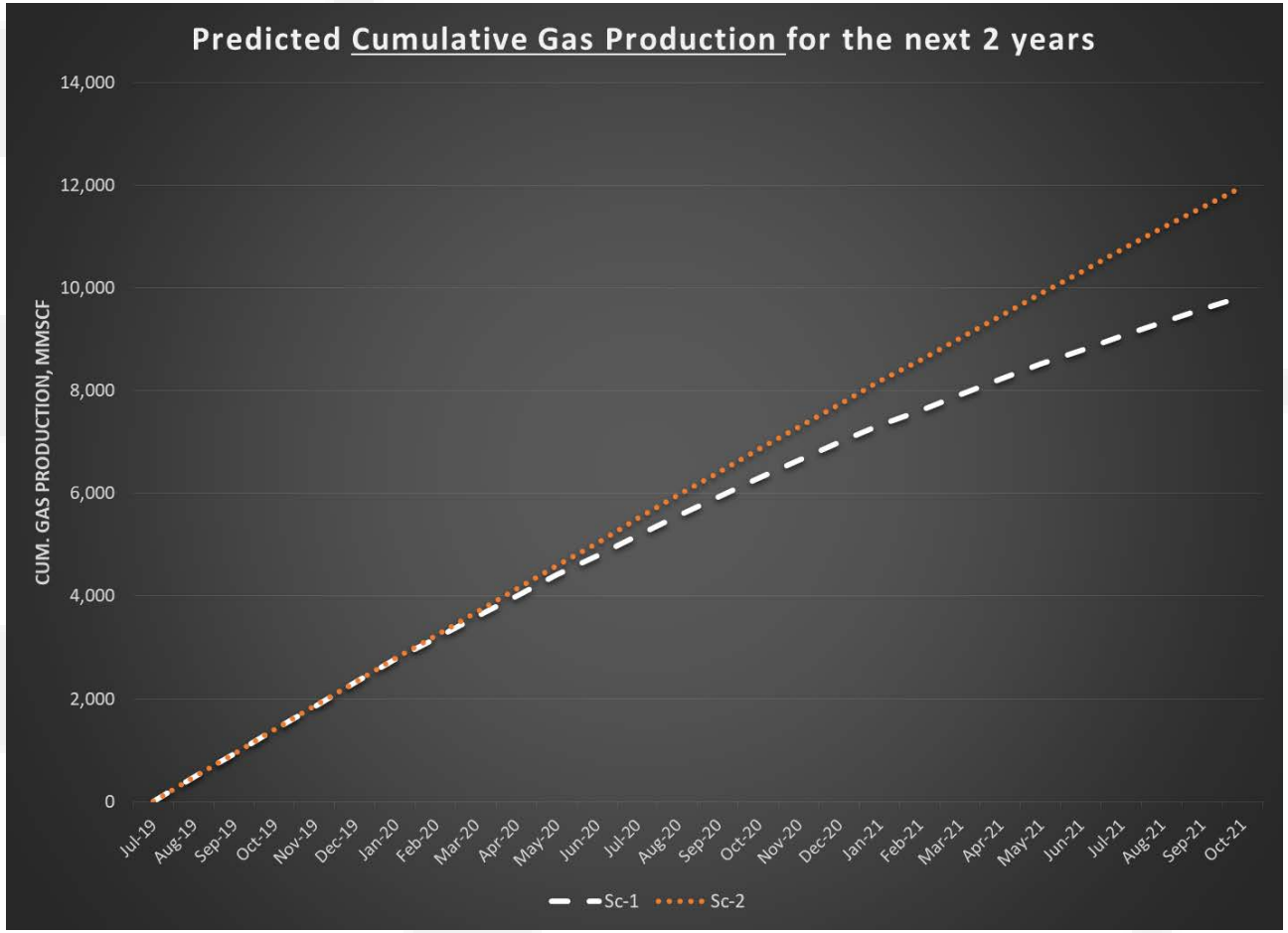
Beginning from July of	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
Ending on July of	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	**2020**
Gas Production (BCF)	7.155	7.279	8.154	7.797	6.669	5.322	4.272	6.353	6.426	5.823	**5.23**
Gas Injection (BCF)	-0.209	0	0	0	-0.021	-0.08	-0.1	-0.01	0	0	**-0.182**
Net Gas Production (BCF)	6.946	7.279	8.154	7.797	6.648	5.242	4.172	6.343	6.426	5.823	**5.048**
Year over Year Change,%		4.79	12.02	-4.38	-14.74	-21.15	-20.41	52.04	1.31	-9.38	**-13.3**

The **total** Gas production in 2019-20 has decreased from 5.823 to 5.23 BCF, showing 10.18% YoY decline.

Due to the Gas re-injection, the **NET** Gas production in 2019-20 has decreased from 5.823 to 5.048 BCF, showing 13.3% YoY decline.

Review of Last year's Predictions

Cumulative Gas Production Forecast



Scenario Number	Scenario Name
1	Base Case
2	Base Case + New Compressor

Predicted Gas Production (BCF)

	Sce-1	Sce-2
1 July-1 Oct 2019	1.397	1.399
FY 2020	4.89	5.45
FY 2021	3.55	5.12

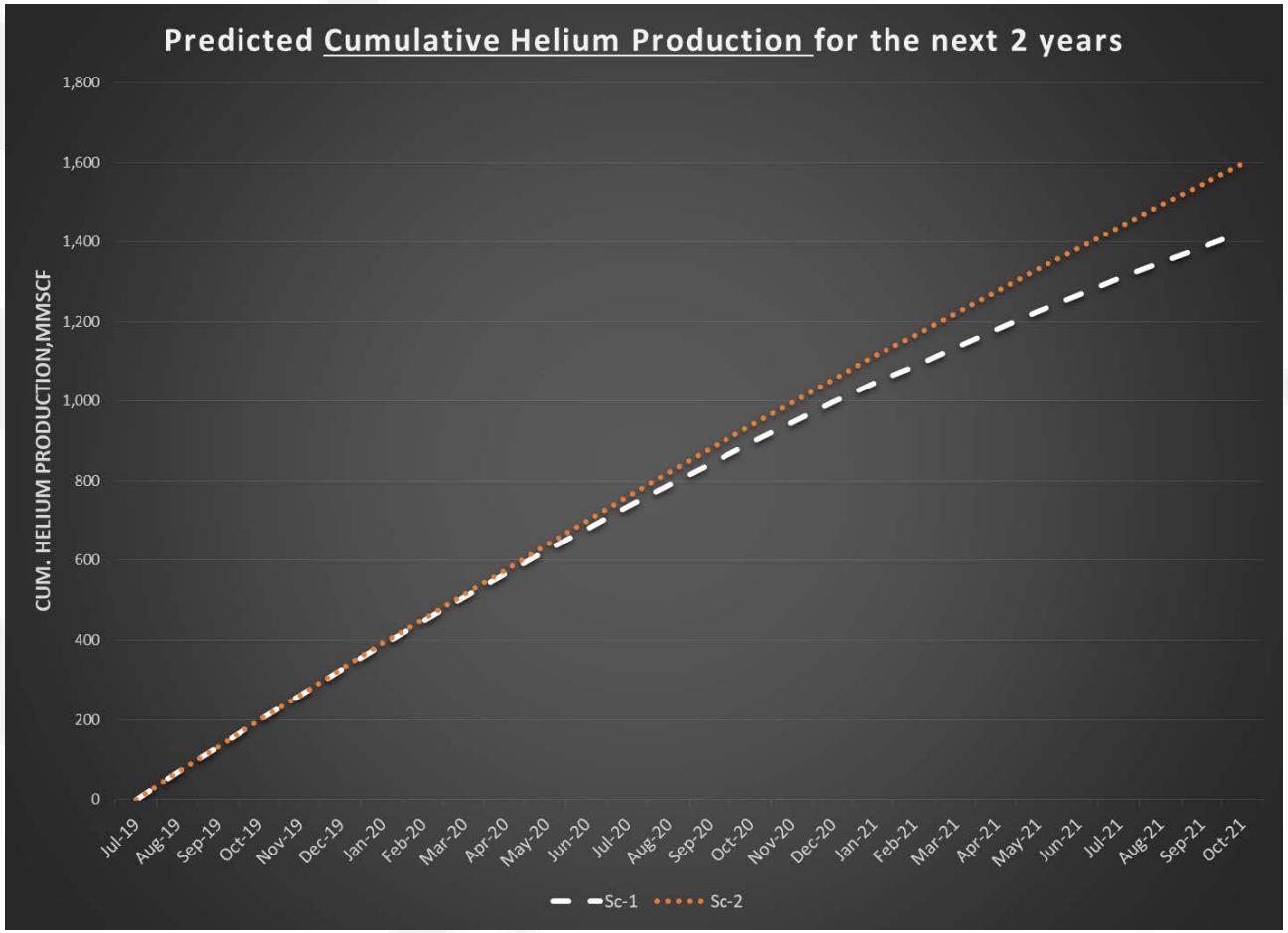
Actual cum. Gas of 5.23 BCF versus predicted cum. Gas of 5.45 BCF.

Actual versus Predicted Annual Gas Production from July 2019 to July 2020

Scenario Name	Actual Cumulative Gas production (MMSCF) Jul 2019-July 2020	Predicted Cumulative Gas production (MMSCF) Jul 2019-July 2020
Base Case + New Compressor	5.23	5.45

The difference between the actual and predicted total gas production is only 1.5% which demonstrates a great prediction

Cumulative Helium Production Forecast



Scenario Number	Scenario Name
1	Base Case
2	Base Case + New Compressor

Predicted He Production (MMCF)

	Sce-1	Sce-2
1 July-1 Oct 2019	198.0	198.4
FY 2020	697.1	740.2
FY 2021	528.2	656.1

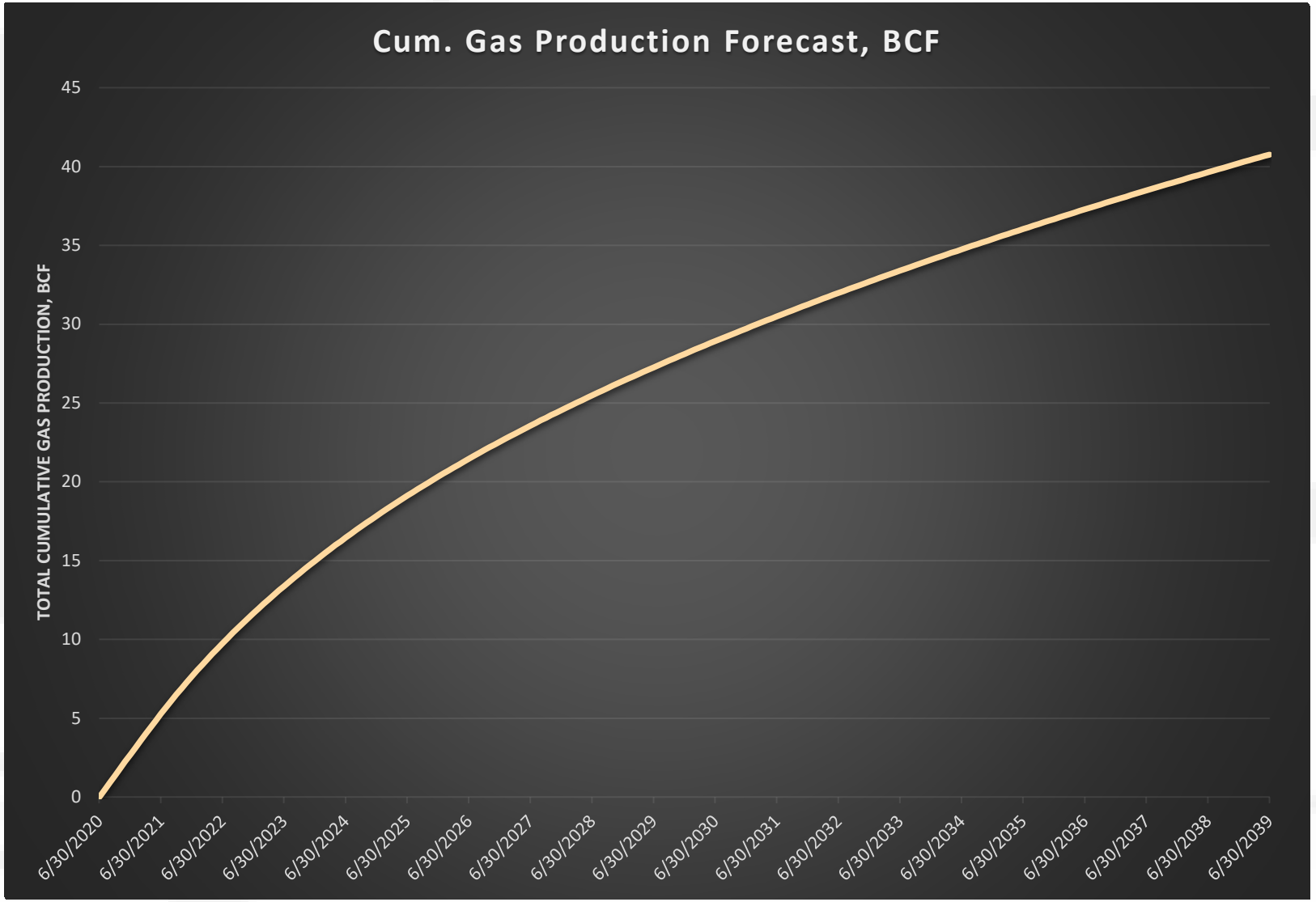
Actual cum. helium of 752 MMCF versus predicted cum. Gas of 740.2 MMCF.

Actual versus Predicted Annual Helium Production from July 2019 to July 2020

Scenario Name	Actual Cumulative He production (MMSCF) Jul 2019-July 2020	Predicted Cumulative He production (MMSCF) Jul 2019-July 2020
Base Case + New Compressor	752	740.2

The difference between the actual and predicted helium production is only 4% which demonstrates a great prediction

Cumulative Production Forecast for the next 20 years



This forecast assumes current production setup remains unchanged. Any change in adding/removing compressors, drilling or shutting wells, acidizing, etc. will change the forecasts.

Total Gas and Helium Production Forecast for FY 20-21

- By considering the current production conditions and without major changes (compressor changes, well stimulation methods, shutting wells, etc.) and Considering 5% accuracy margin, the cumulative gas production is estimated to be between 4.61 and 5.1 BCF for the next fiscal year.
- Assuming 12.4% helium fraction concentration in produced gas, the forecasted helium production will be approximately between 571 to 631 Million SCF.

Conclusions and Summary

- By comparing the production rates and volumes in 2019-20 with the year before, it is evident that almost all the production indices have declined.
- Despite lots of operational changes, last year's model predicted the total gas and helium production values very well.
- The predicted cumulative gas production estimate was off by only 1.5% and the predicted helium production was off by 4% from the actual results.
- This is a great prediction!
- For 2020-2021 fiscal year, the total gas production is estimated to be between 4.61 and 5.1 BCF.
- For 2020-2021 fiscal year, the total helium production is estimated to be between 571 to 631 Million SCF.

Conclusions and Summary (con't)

- Results of the Pressure Transient Analysis indicated that the near-wellbore damage has grown in the wells in the past couple years. So, performing quick acidizing methods are recommended.

- Active wells were categorized into three groups to maximize helium production using acidizing. Depending on the budget and management team's strategy, prioritization of wells for acidizing will be defined.

- Recent installation of the 2nd compressor has helped boost the production and slow down the production declines. The rates after 2nd compressor installation in November 2019 has increased the gas rates to the values approximately in April 2019.

- So far Bush Dome reservoir has been exploited as a conventional gas reservoir. Completion history showed low contacted area (low perforation density), conservative (low volume) acid stimulation jobs, no hydraulic fracture implementation, and production tubing that limited gas production.

- The reservoir pressure is declining relatively fast and so is the production rate. The results of the studies show the fastest and cheapest production enhancement scenario in short term are acidizing the wells. Suggestions were provided on the highest to lowest priority for acidizing job.

Edge Geoscience Inc.

THANKS FOR YOUR ATTENTION

VAHID SERAJIAN
EDGE GEOSCIENCE INC.
17 JULY 2020