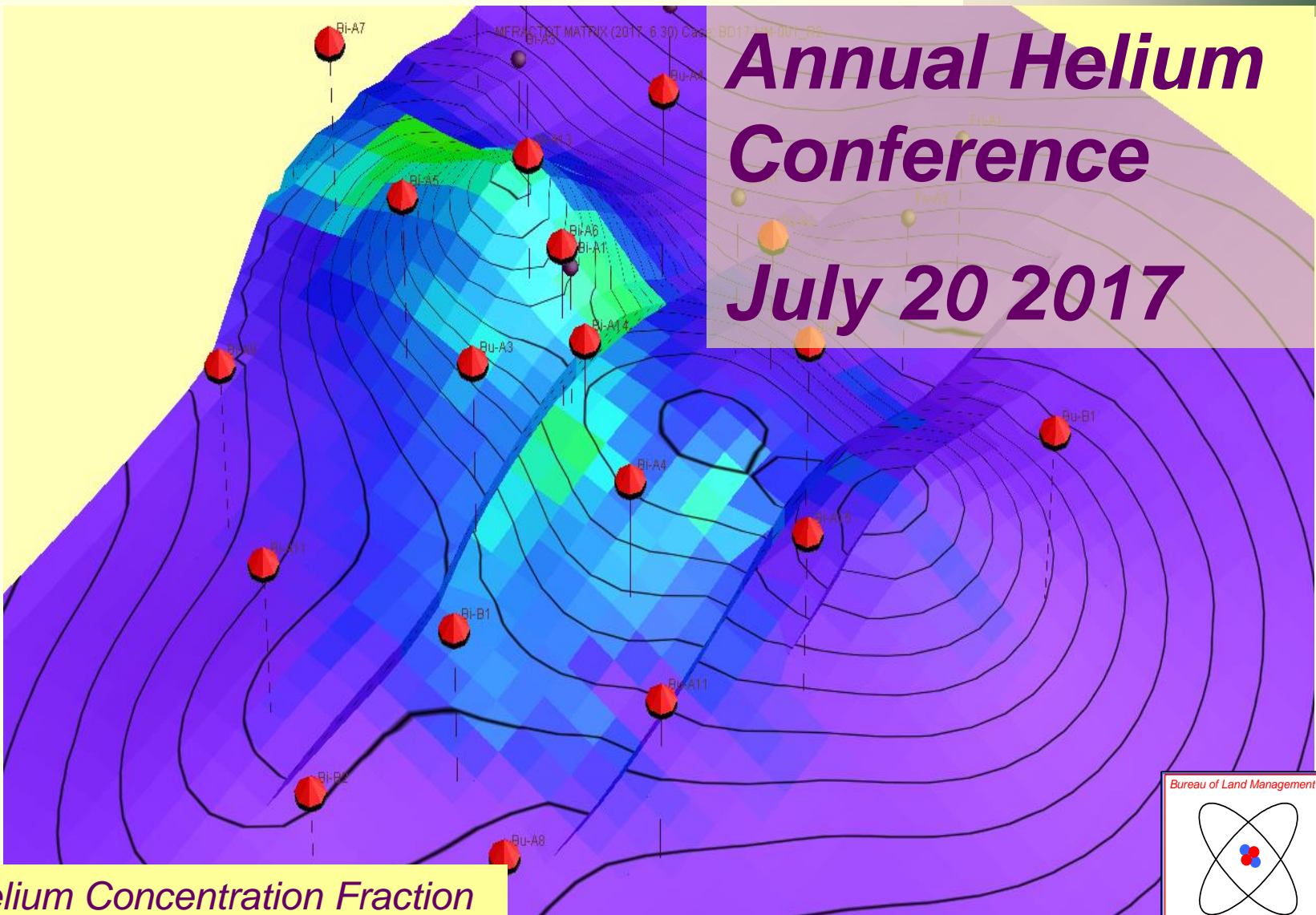


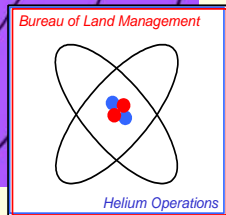
# Bush Dome Helium Reservoir



**Annual Helium  
Conference  
July 20 2017**



**Helium Concentration Fraction  
June 30 2017**



# Disclaimer



- *Predictions of the Bush Dome reservoir's future performance, plus any other analysis contained within this presentation, are interpretive, using accepted reservoir engineering practices with the data made available for this work. NITEC LLC does not warrant or guarantee that any interpretation or proposed operation will perform as forecast.*

# Outline



- Reservoir Status (Operations: 2016-2017)
- Simulation Model Status
- Predictions
- Conclusions



*Tour de France -2017*

# Reservoir Status 2017



- Field Operations Summary:
  - July 2016 – 2017
  - Comparison to prior years
  - Bi-A6 Summary
- Production Analysis
- Helium Concentration Maps
- Flowing WHP
- Water Encroachment

# Reservoir Status 2017



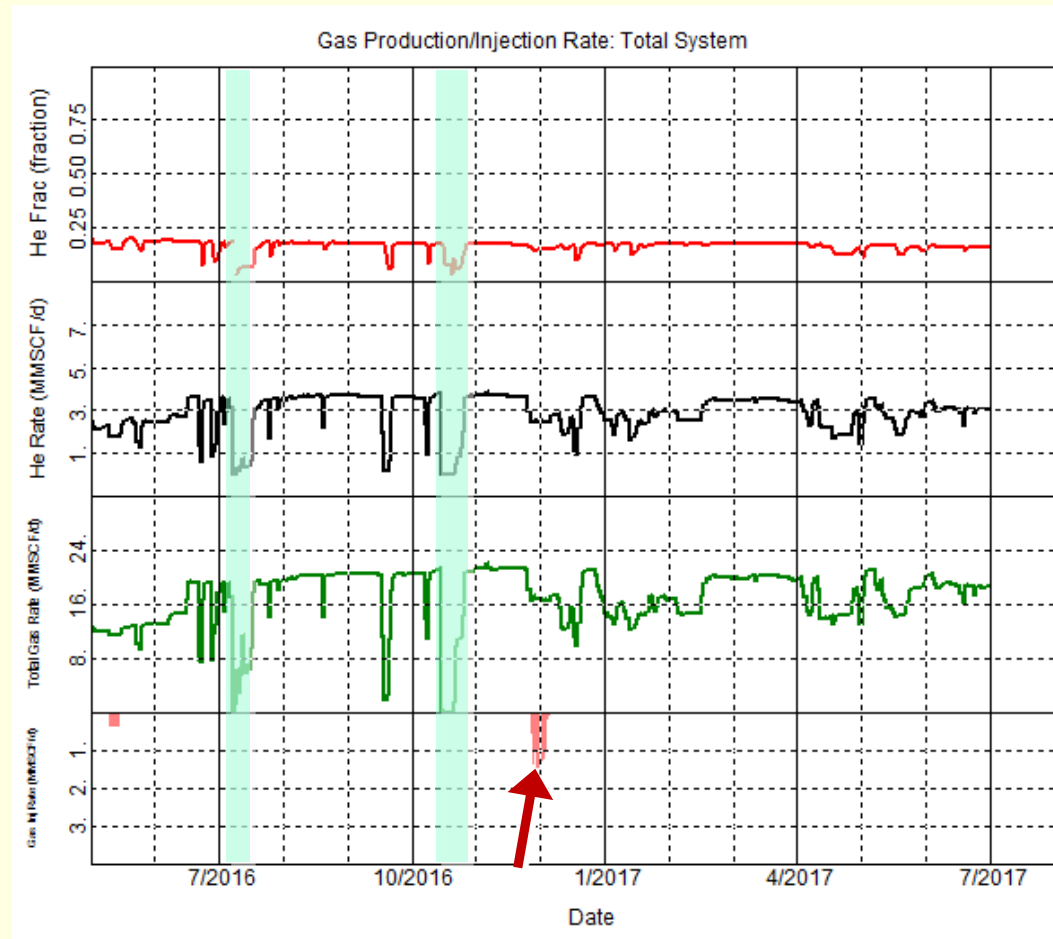
## ■ Summary – 2016-17 Operations

- Field/HEU currently at or close to minimum suction pressure and maximum flow
- High and low helium demand periods throughout the year (July 2016 – July 2017)
- Central compression installed but not up and running
- Small volume of crude helium was injected in Dec 2016
- Water encroachment impacts some wells
- Overall reservoir performance was as expected, given flowing pressure constraints

# Reservoir Status 2017



| Field & HEU Summary     |        |      |
|-------------------------|--------|------|
| July-July<br>2016-17    |        |      |
| HEU Operating           | 347    | days |
| HEU Down                | 18     | days |
| He rate < 1MM/d         | 7      | days |
| He rate > 6.25mm/d      | 0      | days |
|                         |        |      |
| Beg. Avg Flowing Press  | 229.0  | psia |
| End Avg Flowing Press   | 197.0  | psia |
| Change in Flowing Press | -32.0  | psi  |
|                         |        |      |
| Total Gas Produced      | 6.353  | BCF  |
| Total Gas Injected      | -0.010 | BCF  |
| Net Gas                 | 6.343  | BCF  |
|                         |        |      |
| He Produced             | 1.059  | BCF  |
| He Injected             | -0.007 | BCF  |
| He Net                  | 1.052  | BCF  |



# Reservoir Status 2017



- **Summary – 2016-17 Operations: High Demand**
  - High He demand periods: Sep – Nov, May – Jun
  - Current period:
    - 38 Days flowing 190-193 psia at HEU
    - Total Gas rate (MMcf/d): Max 21.1, Min 15.9, Avg 19.5
    - Helium rate (MMcf/d): Max 3.5, Min 2.3, Avg 3.3

# Reservoir Status 2017



## Summary – 2016-17 Operations: high He rate





# Reservoir Status 2017

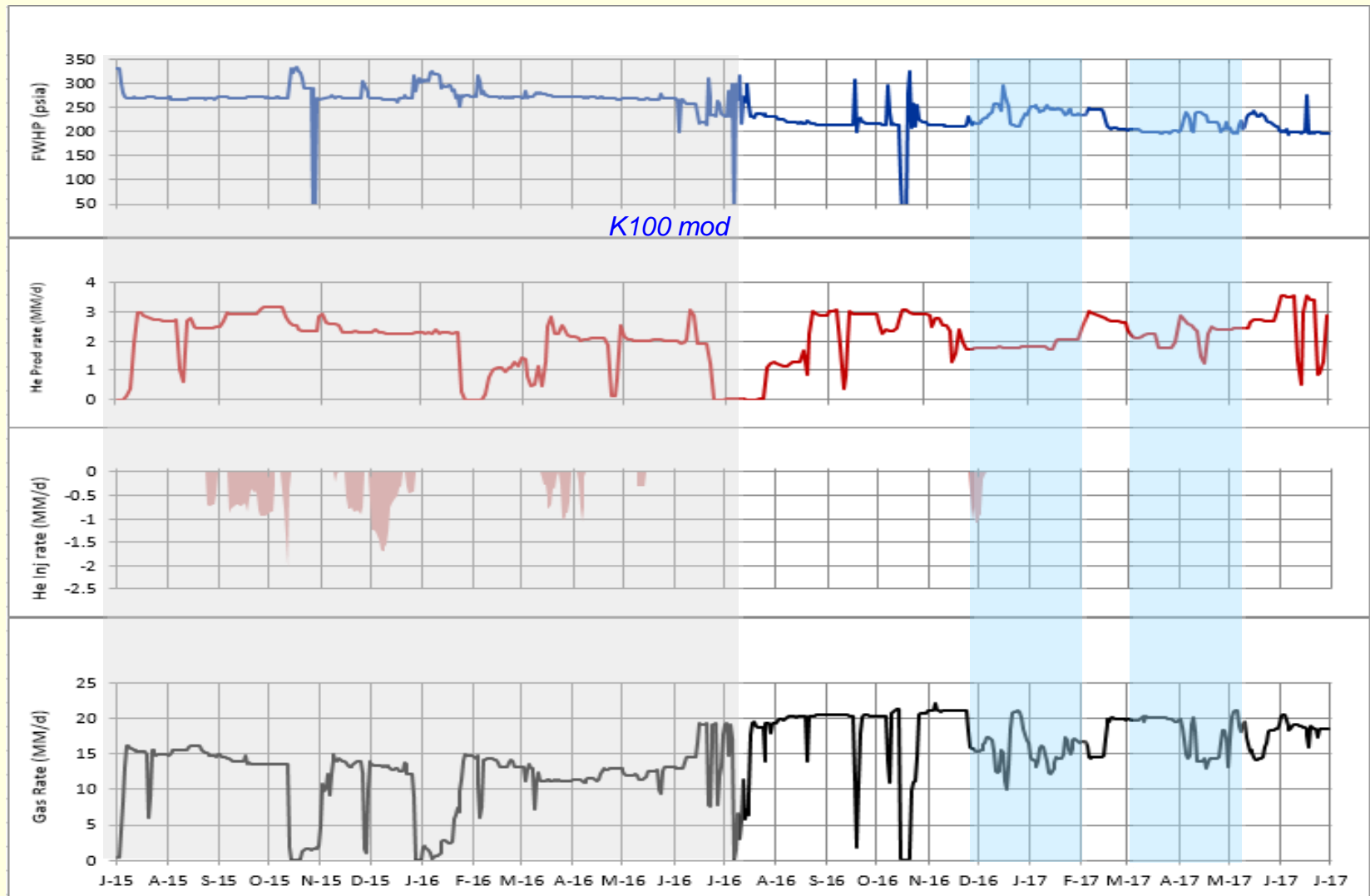


- **Summary – 2016-17 Operations: Low Demand**
  - Low He demand periods: Dec – Feb, Mar – May
  - Dec-Feb period:
    - Some gas injection in Dec
    - Lowest total gas rate, 6 days at < 12.5 MM/d}  
helium average rate ~ 1.7 MM/d
  - Mar- May period:
    - Initially high total gas rate ~20 MM/d, reduced to 15 MM/d
    - Helium average rate ~2.2 MM/d, lowest ~1.7 MM/d
    - No gas injection

# Reservoir Status 2017



## Summary – 2016-17 Operations: low He rate





- **Summary – 2016-17 Operations: min Pressure**
  - Current K100 modifications (2016) provide for minimum flowing pressure of ~182 psig (~197 psia FWHP)
  - Additional modifications have been proposed but have not yet been implemented
  - Central compressor is installed, but not on-line  
It will provide significantly lower flowing pressures (~50 psig, ~75 psia FWHP)

# Reservoir Status 2017



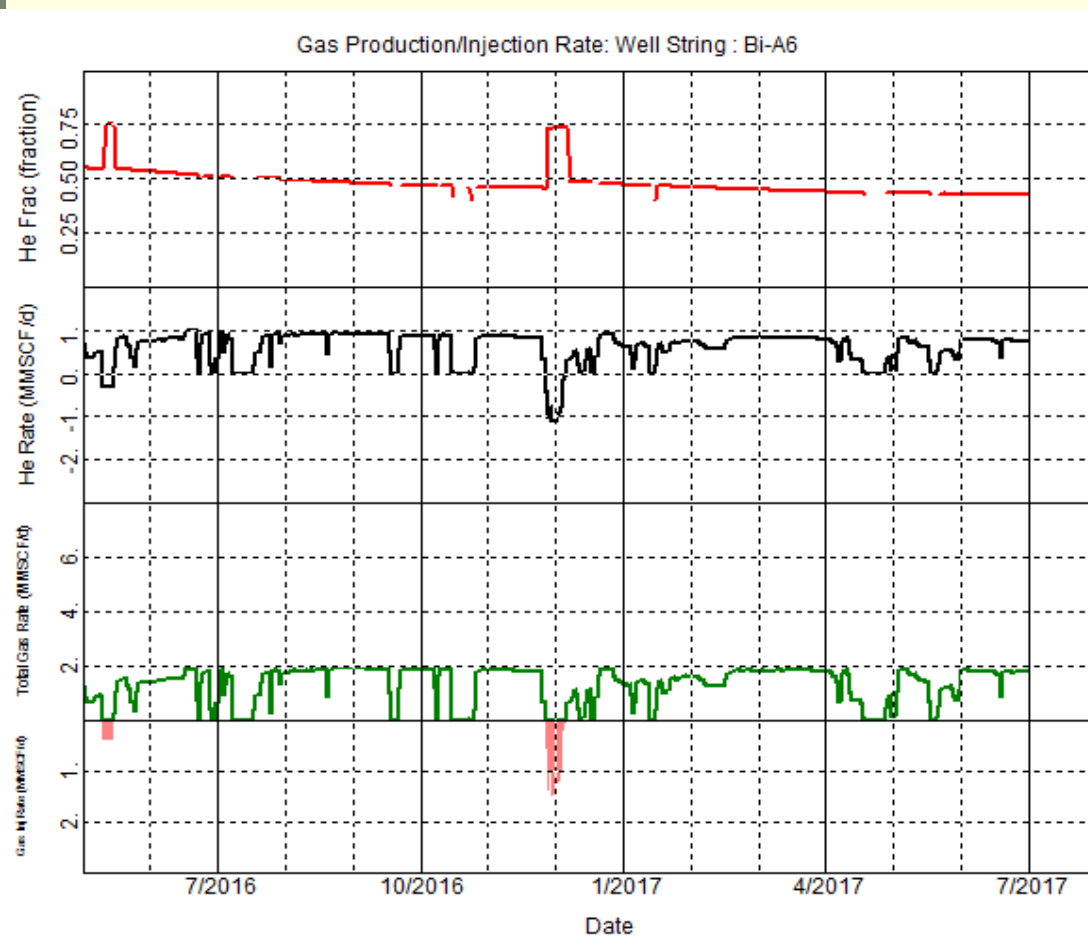
## Summary – 2016-17 Operations: Pmin



# Reservoir Status 2017



## Summary – 2016-17 Operations: Bi-A6



| Bi-A6 Summary                                 |     |      |
|---|-----|------|
| July-July<br>2016-17                          |     |      |
| Producing                                     | 322 | days |
| Injecting                                     | 10  | days |
| No Flow                                       | 33  | days |
| <b>Total Gas Produced</b> 493.76 MM           |     |      |
| <b>Total Gas Injected</b> -9.8 MM             |     |      |
| <b>Net Gas</b> 484.0 MM                       |     |      |
| <b>He produced</b> 234.879 MM                 |     |      |
| <b>He injected</b> -7.2 MM                    |     |      |
| <b>Net He</b> 227.7 MM                        |     |      |
| <b>Beginning He %</b> 48.59%                  |     |      |
| <b>Ending He%</b> 45.27%                      |     |      |
| <b>Change in He%</b> -3.32%                   |     |      |
| <b>Bi-A6 produced 22% of 2016-2017 Helium</b> |     |      |
| <b>Bi-A6 He % range 45.2% - 74.2%</b>         |     |      |

# Reservoir Status 2017



| Field & HEU Summary     |        |      |
|-------------------------|--------|------|
| July-July<br>2016-17    |        |      |
| HEU Operating           | 347    | days |
| HEU Down                | 18     | days |
| He rate < 1MM/d         | 7      | days |
| He rate > 6.25mm/d      | 0      | days |
|                         |        |      |
| Beg. Avg Flowing Press  | 232.0  | psia |
| End Avg Flowing Press   | 197.0  | psia |
| Change in Flowing Press | -35.0  | psi  |
|                         |        |      |
| Total Gas Produced      | 6.353  | BCF  |
| Total Gas Injected      | -0.010 | BCF  |
| Net Gas                 | 6.343  | BCF  |
|                         |        |      |
| He Produced             | 1.059  | BCF  |
| He Injected             | -0.007 | BCF  |
| He Net                  | 1.052  | BCF  |

| Bi-A6 Summary                          |         |      |
|--|---------|------|
| July-July<br>2016-17                   |         |      |
| Producing                              | 322     | days |
| Injecting                              | 10      | days |
| No Flow                                | 33      | days |
|  |         |      |
| Total Gas Produced                     | 493.76  | MM   |
| Total Gas Injected                     | -9.8    | MM   |
| Net Gas                                | 484.0   | MM   |
|  |         |      |
| He produced                            | 234.879 | MM   |
| He injected                            | -7.2    | MM   |
| Net He                                 | 227.7   | MM   |
|  |         |      |
| Beginning He %                         | 48.59%  |      |
| Ending He %                            | 45.27%  |      |
| Change in He %                         | -3.32%  |      |
| Bi-A6 produced 22% of 2016-2017 Helium |         |      |
| Bi-A6 He % range 45.2% - 74.2%         |         |      |

# Reservoir Status 2017



## Field Production: 2012- 2017

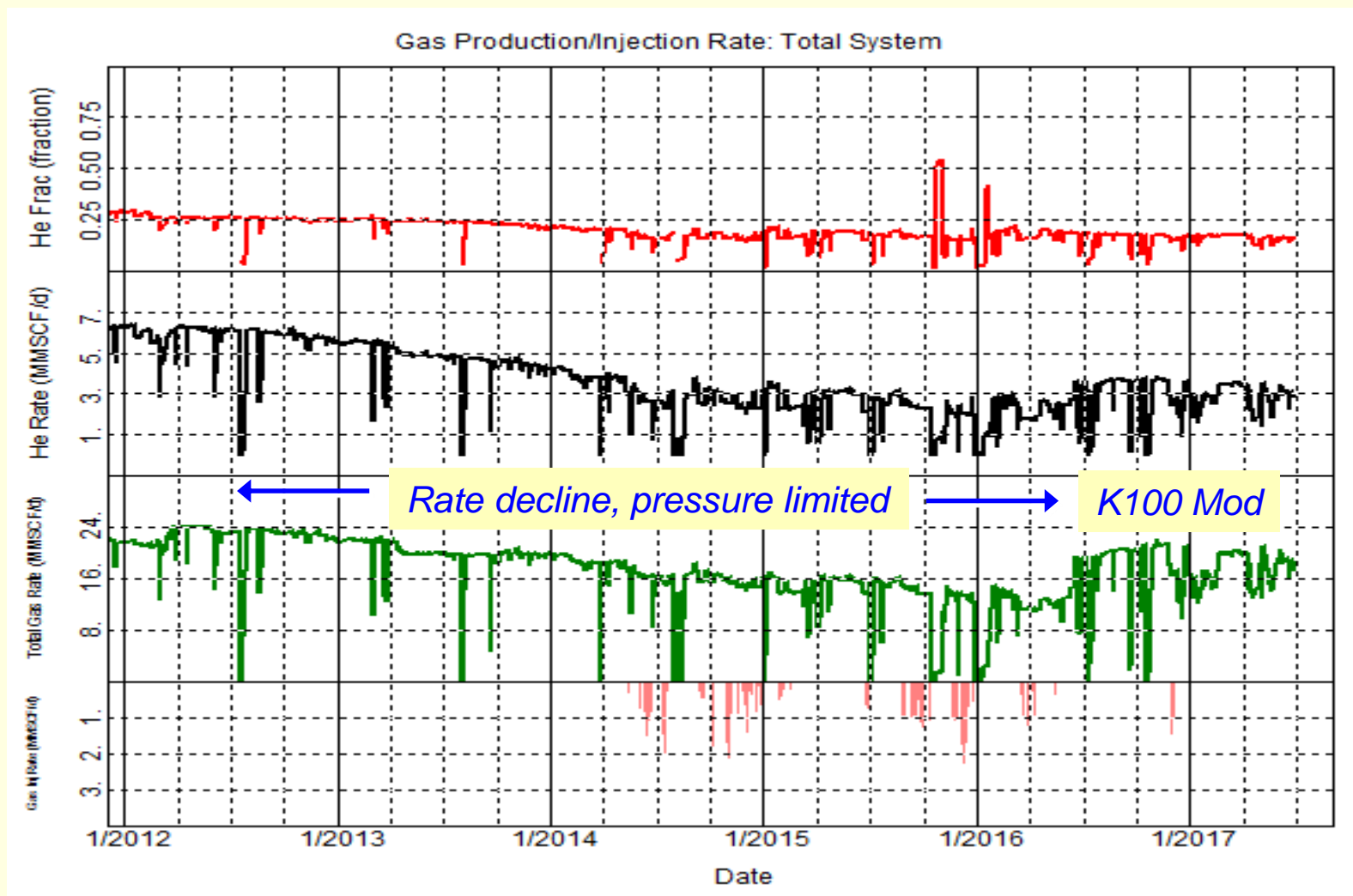
| Field & HEU Summary |                |       |        |        |        |        |        |
|---------------------|----------------|-------|--------|--------|--------|--------|--------|
|                     | beginning July | 2012  | 2013   | 2014   | 2015   | 2016   | 5 Year |
|                     | ending July    | 2013  | 2014   | 2015   | 2016   | 2017   | Totals |
| HEU Operating       | days           | 361   | 359    | 355    | 307    | 347    | 1729   |
| HEU Down            | days           | 4     | 6      | 10     | 58     | 18     | 96     |
| He rate < 1MM/d     | days           | 4     | 11     | 29     | 45     | 7      | 96     |
| He rate > 6.25mm/d  | days           | 3     | 0      | 0      | 0      | 0      | 3      |
|                     |                |       |        |        |        |        |        |
| Beginning Pressure  | psia           | 278** | 287**  | 277**  | 255**  | 232**  | 278**  |
| Ending Pressure     | psia           | 251** | 277**  | 255**  | 232**  | 197**  | 197**  |
| Change              | psi            | -27   | -10    | -22    | -23    | -35    | -81    |
|                     |                |       |        |        |        |        |        |
| Total Gas Produced  | BCF            | 7.797 | 6.669  | 5.322  | 4.272  | 6.353  | 30.413 |
| Total Gas Injected  | BCF            | 0.000 | -0.021 | -0.080 | -0.100 | -0.010 | -0.211 |
| Net Gas             | BCF            | 7.797 | 6.648  | 5.242  | 4.172  | 6.343  | 30.202 |
|                     |                |       |        |        |        |        |        |
| He Produced         | BCF            | 1.970 | 1.428  | 0.916  | 0.751  | 1.059  | 6.123  |
| He Injected         | BCF            | 0.000 | -0.015 | -0.060 | -0.074 | -0.007 | -0.156 |
| He Net              | BCF            | 1.970 | 1.412  | 0.856  | 0.677  | 1.052  | 5.967  |

K100 Modified

# Reservoir Status 2017



## Field Production: 2012 – 2017 (5 years)





# Reservoir Status 2017



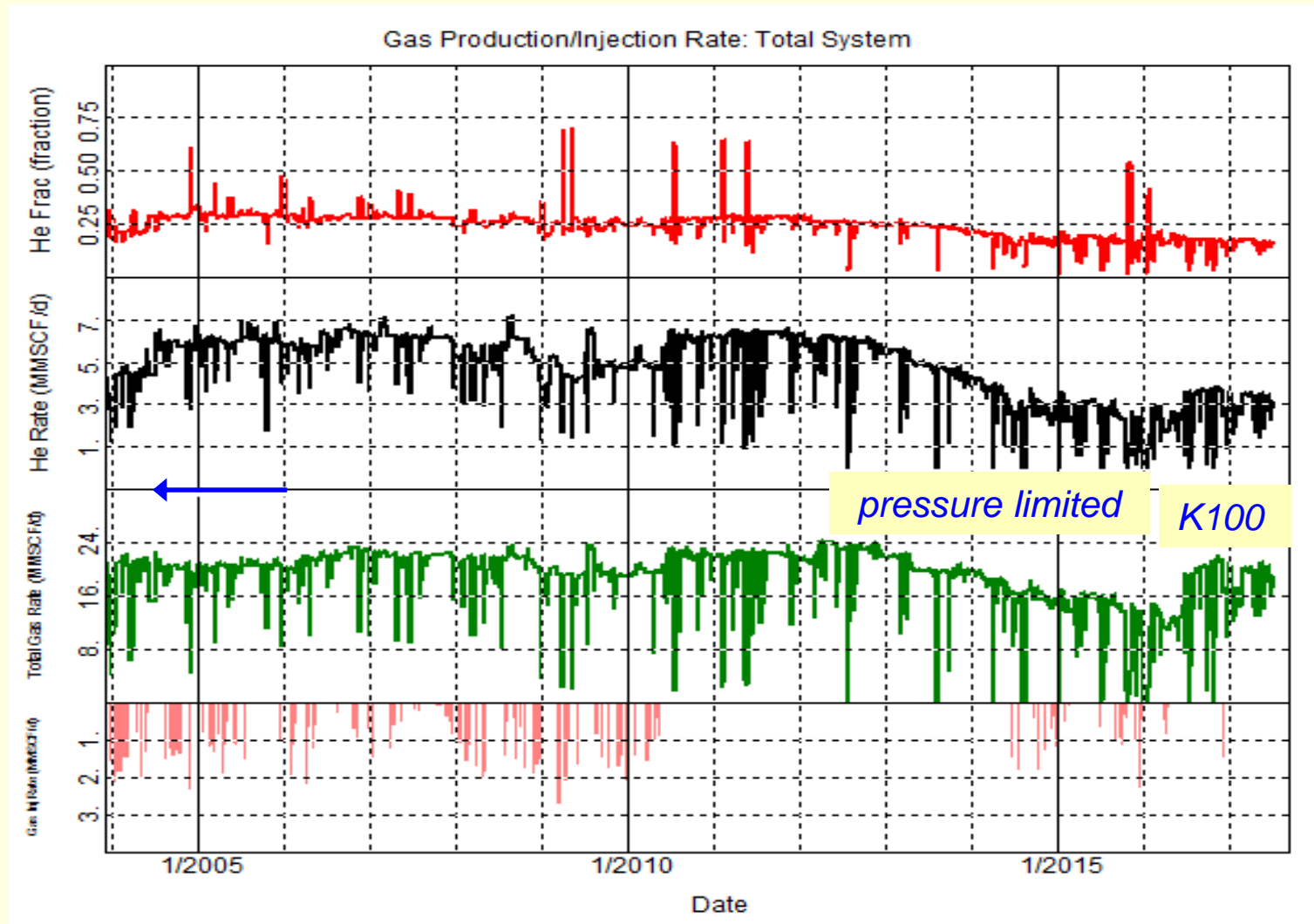
## Field Production: 2004 - 2017

| Field & HEU Summary |                |        |        |        |        |        |       |       |       |        |        |        |        |        |         |
|---------------------|----------------|--------|--------|--------|--------|--------|-------|-------|-------|--------|--------|--------|--------|--------|---------|
|                     | beginning July | 2004   | 2005   | 2006   | 2007   | 2009   | 2010  | 2011  | 2012  | 2013   | 2014   | 2015   | 2016   | 5 Year | 2004-17 |
|                     | ending July    | 2005   | 2006   | 2007   | 2008   | 2010   | 2011  | 2012  | 2013  | 2014   | 2015   | 2016   | 2017   | Totals | Totals  |
| HEU Operating       | days           | 332    | 348    | 334    | 351    | 361    | 351   | 355   | 361   | 359    | 355    | 307    | 347    | 1729   | 4161    |
| HEU Down            | days           | 33     | 17     | 31     | 15     | 4      | 14    | 0     | 4     | 6      | 10     | 58     | 18     | 96     | 210     |
| He rate < 1MM/d     | days           | 35     | 0      | 0      | 1      | 0      | 2     | 0     | 4     | 11     | 29     | 45     | 7      | 96     | 134     |
| He rate > 6.25mm/d  | days           | 30     | 82     | 189    | 43     | 28     | 222   | 242   | 3     | 0      | 0      | 0      | 0      | 3      | 839     |
|                     |                |        |        |        |        |        |       |       |       |        |        |        |        |        |         |
| Beginning Pressure  | psia           | 626    | 601    | 575    | 548    | 362**  | 334** | 310** | 278** | 287**  | 277**  | 255**  | 232**  | 278**  | 626     |
| Ending Pressure     | psia           | 601    | 575    | 548    | 523    | 334**  | 303** | 278** | 251** | 277**  | 255**  | 232**  | 197**  | 197**  | 197**   |
| Change              | psi            | -25    | -26    | -27    | -25    | -28    | -31   | -32   | -27   | -10    | -22    | -23    | -35    | -81    | -429    |
|                     |                |        |        |        |        |        |       |       |       |        |        |        |        |        |         |
| Total Gas Produced  | BCF            | 5.026  | 7.226  | 7.509  | 7.431  | 7.155  | 7.279 | 8.154 | 7.797 | 6.669  | 5.322  | 4.272  | 6.353  | 30.413 | 80.193  |
| Total Gas Injected  | BCF            | -0.060 | -0.041 | -0.060 | -0.183 | -0.209 | 0.000 | 0.000 | 0.000 | -0.021 | -0.080 | -0.100 | -0.010 | -0.211 | -0.764  |
| Net Gas             | BCF            | 4.966  | 7.185  | 7.449  | 7.248  | 6.946  | 7.279 | 8.154 | 7.797 | 6.648  | 5.242  | 4.172  | 6.343  | 30.202 | 79.429  |
|                     |                |        |        |        |        |        |       |       |       |        |        |        |        |        |         |
| He Produced         | BCF            | 1.262  | 2.077  | 2.176  | 1.930  | 1.817  | 2.123 | 2.263 | 1.970 | 1.428  | 0.916  | 0.751  | 1.059  | 6.123  | 19.771  |
| He Injected         | BCF            | -0.047 | -0.033 | -0.048 | -0.144 | -0.163 | 0.000 | 0.000 | 0.000 | -0.015 | -0.060 | -0.074 | -0.007 | -0.156 | -0.590  |
| He Net              | BCF            | 1.215  | 2.045  | 2.128  | 1.786  | 1.654  | 2.123 | 2.263 | 1.970 | 1.412  | 0.856  | 0.677  | 1.052  | 5.967  | 19.182  |
| **Flowing Pressures | K100 Modified  |        |        |        |        |        |       |       |       |        |        |        |        |        |         |

# Reservoir Status 2017



## Field Production: 2004 - 2017



# Reservoir Status 2017



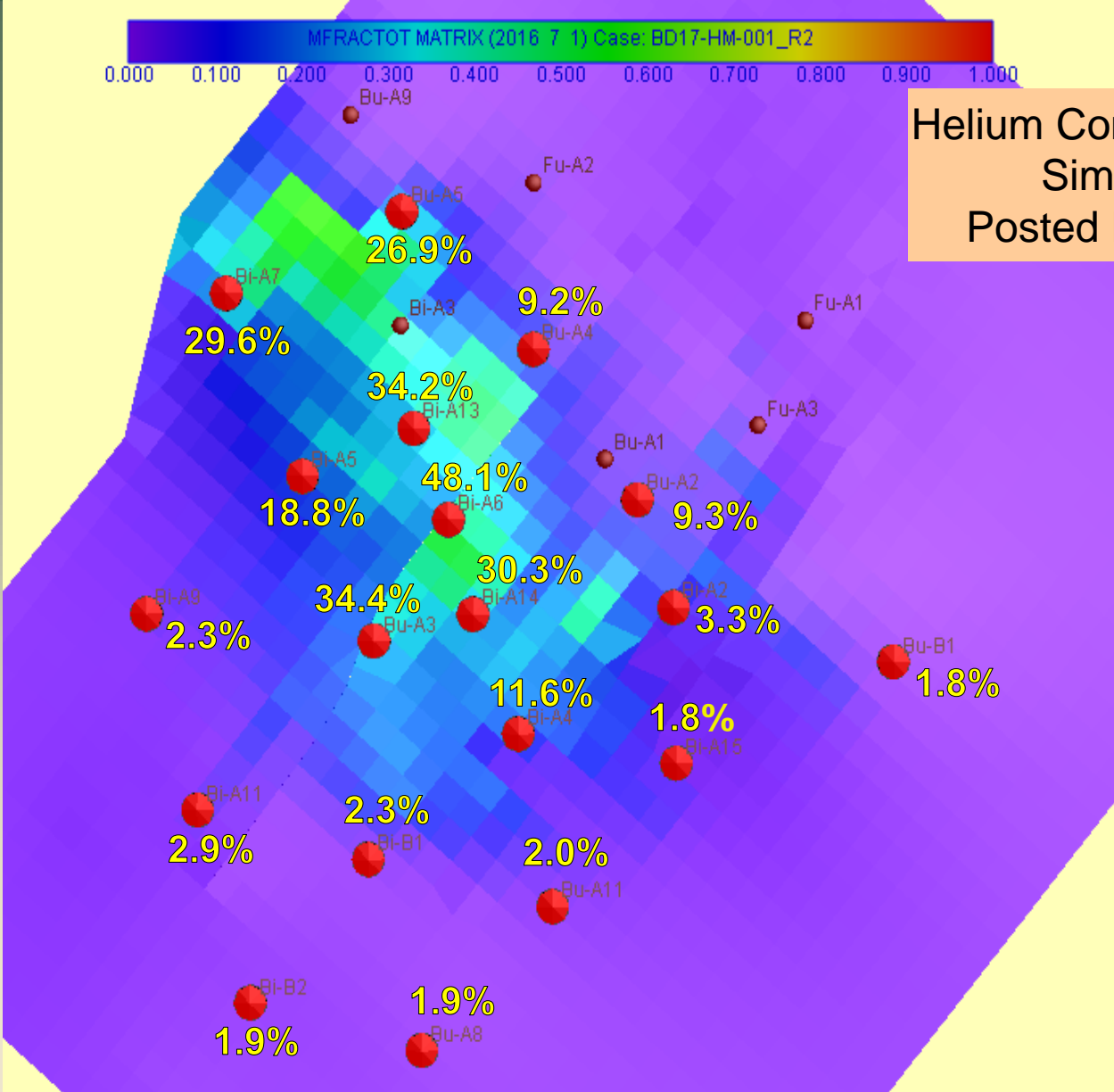
- Helium concentration maps
  - July 1 2016
  - June 30 2017
  - Change in He %
- Flowing WHP – June 30 2017

# Reservoir Status 2017



MFRACOT MATRIX (2016 7 1) Case: BD17-HM-001\_R2  
 0.000 0.100 0.200 0.300 0.400 0.500 0.600 0.700 0.800 0.900 1.000

Helium Concentration – July 2016  
 Sim Model – Layer 7  
 Posted Field Produced HE%

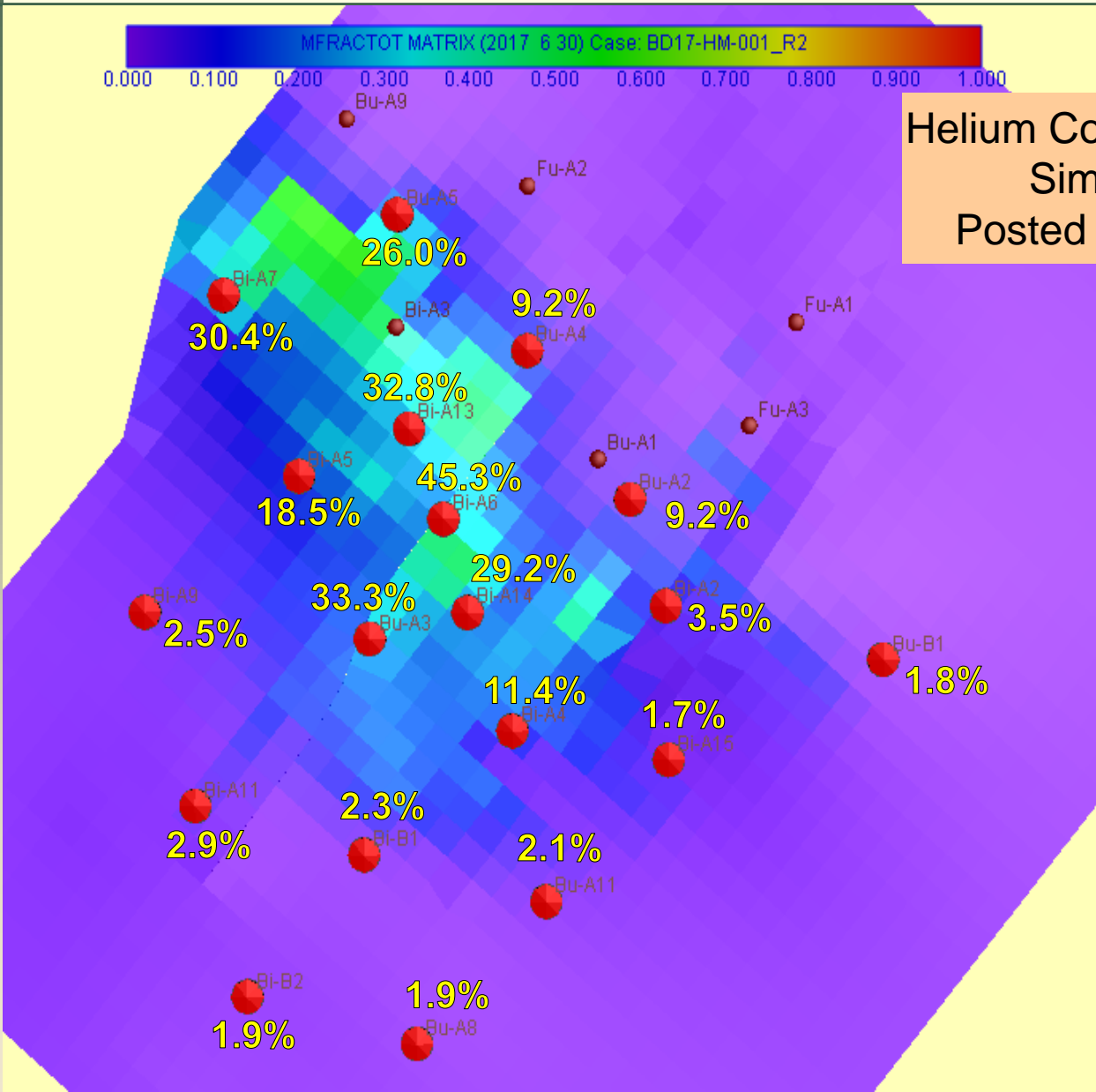


# Reservoir Status 2017



MFRAC TOT MATRIX (2017 6 30) Case: BD17-HM-001\_R2  
 0.000 0.100 0.200 0.300 0.400 0.500 0.600 0.700 0.800 0.900 1.000

Helium Concentration – Jun 2017  
 Sim Model – Layer 7  
 Posted Field Produced HE%

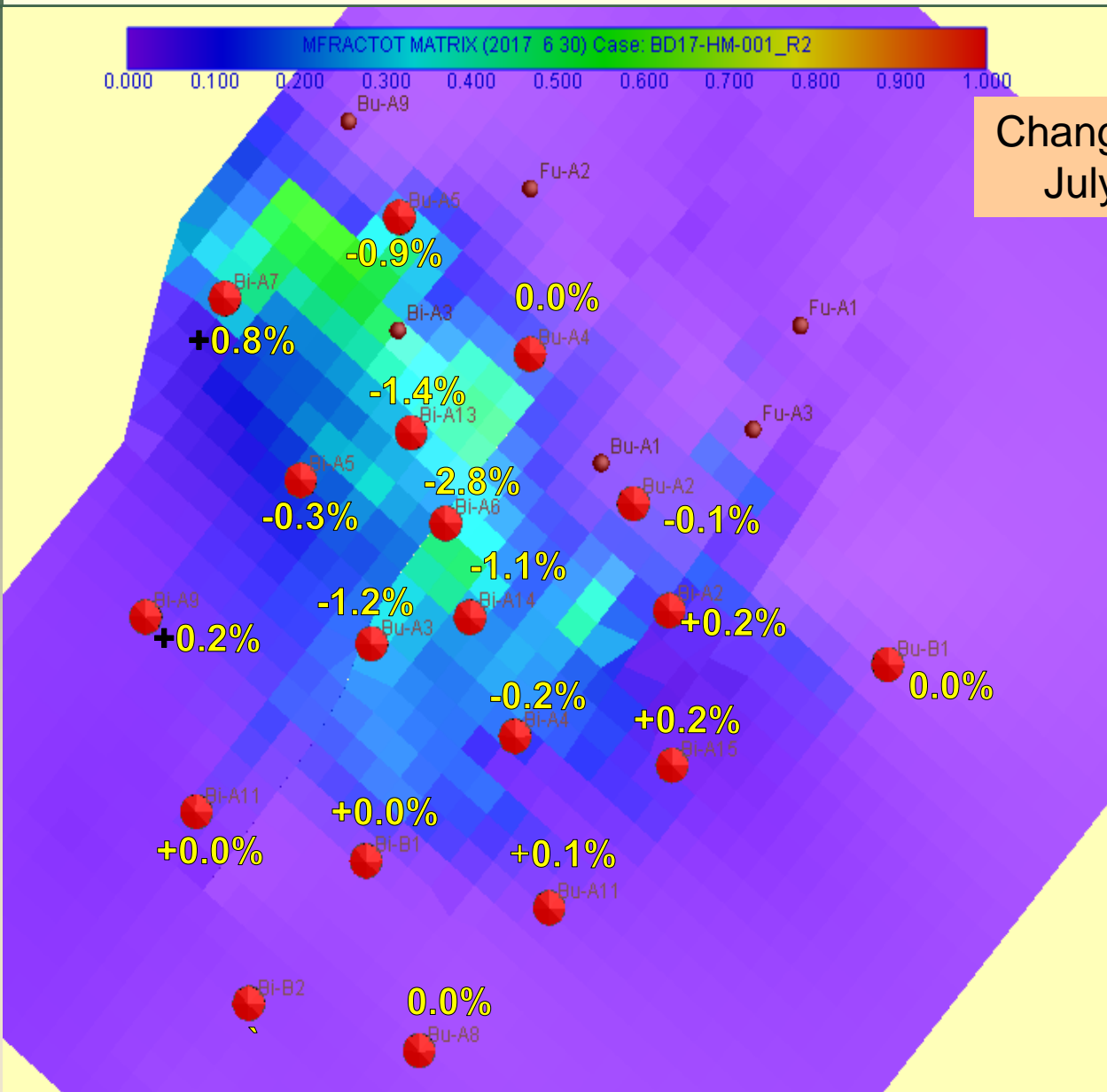


# Reservoir Status 2017

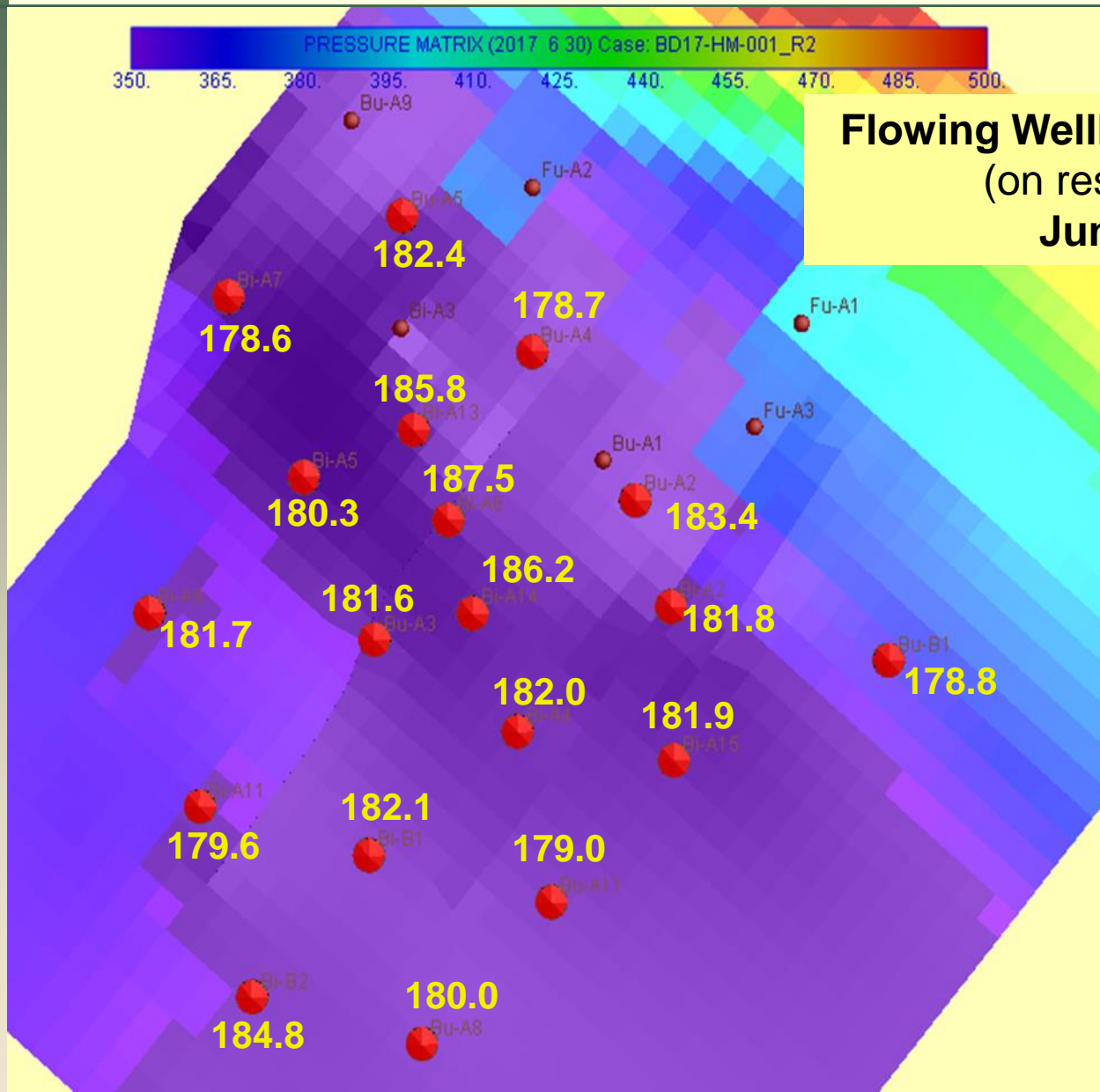


MFRACOT MATRIX (2017 6 30) Case: BD17-HM-001\_R2  
0.000 0.100 0.200 0.300 0.400 0.500 0.600 0.700 0.800 0.900 1.000

Change in He Concentration  
July 2016 to June 2017



# Reservoir Status 2017



**Flowing Wellhead Pressure (FWHP)**  
 (on reservoir pressure)  
 June 2017, psig

# Reservoir Status 2017



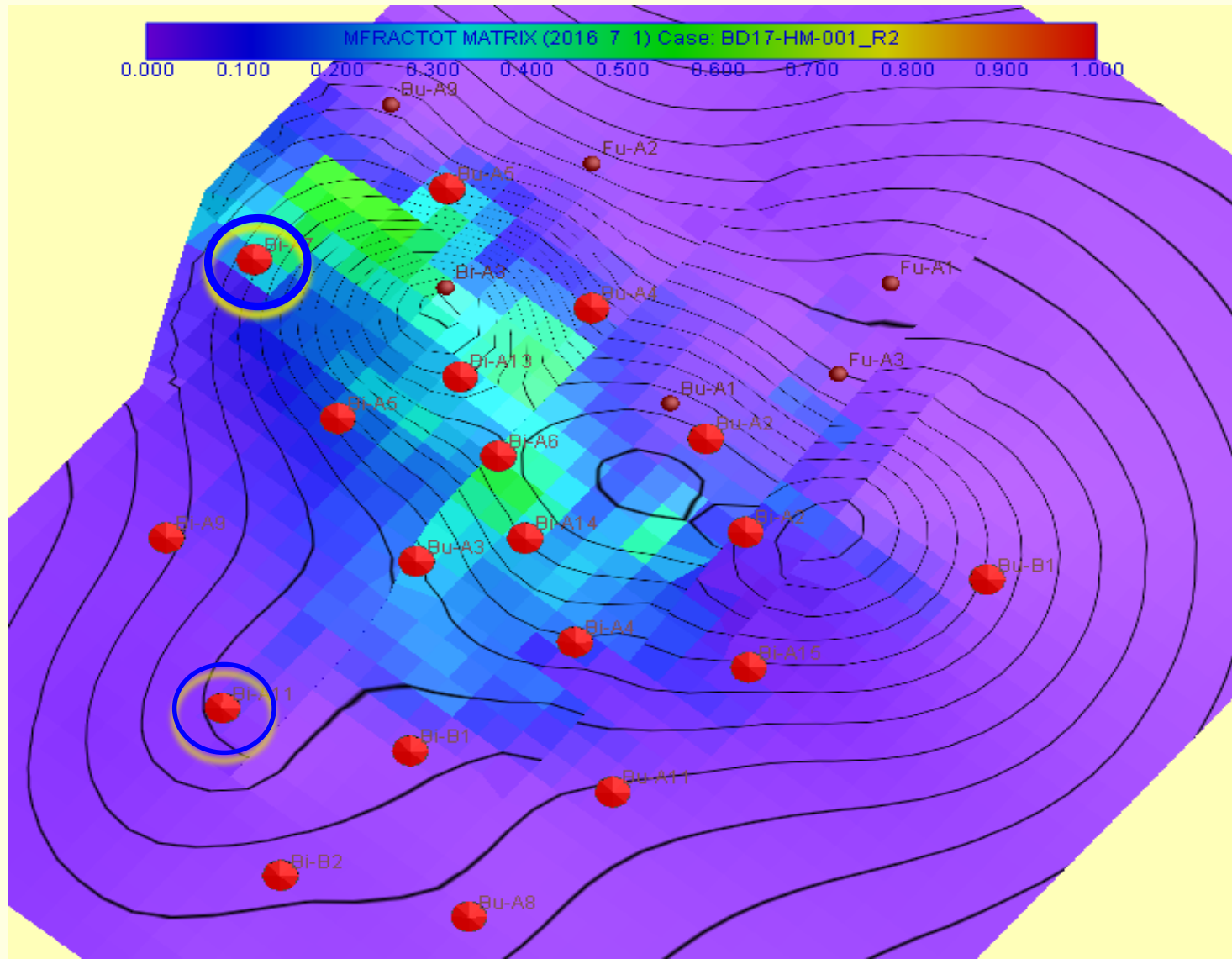
- **Water Encroachment – Well Issues**
  - **2 wells are pulling in water: Bi-A7 & Bi-A11**
  - **Bi-A7:**
    - Helium well in north
    - Was #6 in helium prod, now dropped to #10
  - **Bi-A11:**
    - Methane well in outer area, south & west
    - Impact methane availability for HEU startup
    - Currently flowing normally



# Reservoir Status 2017



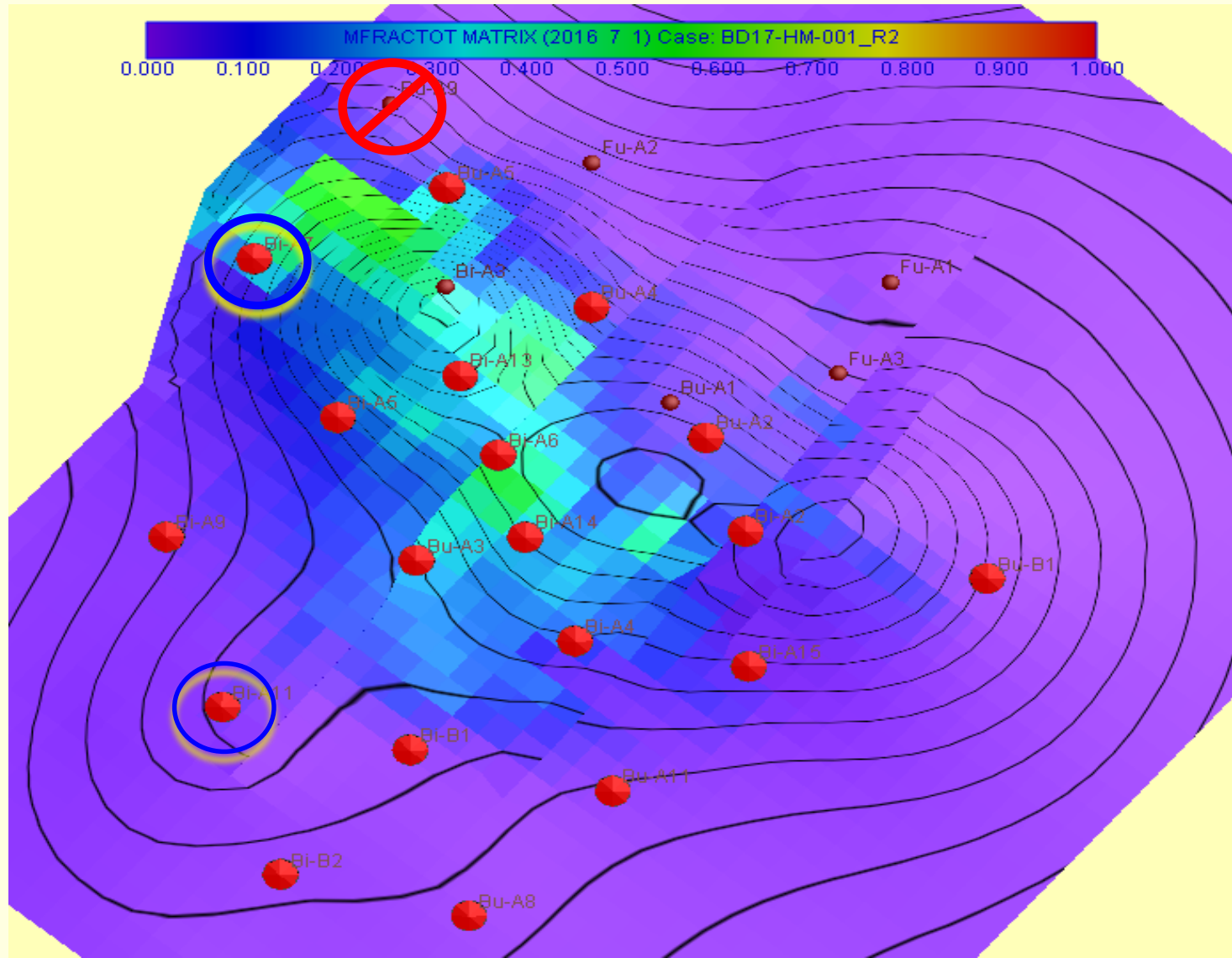
## ■ Water encroachment



# Reservoir Status 2017



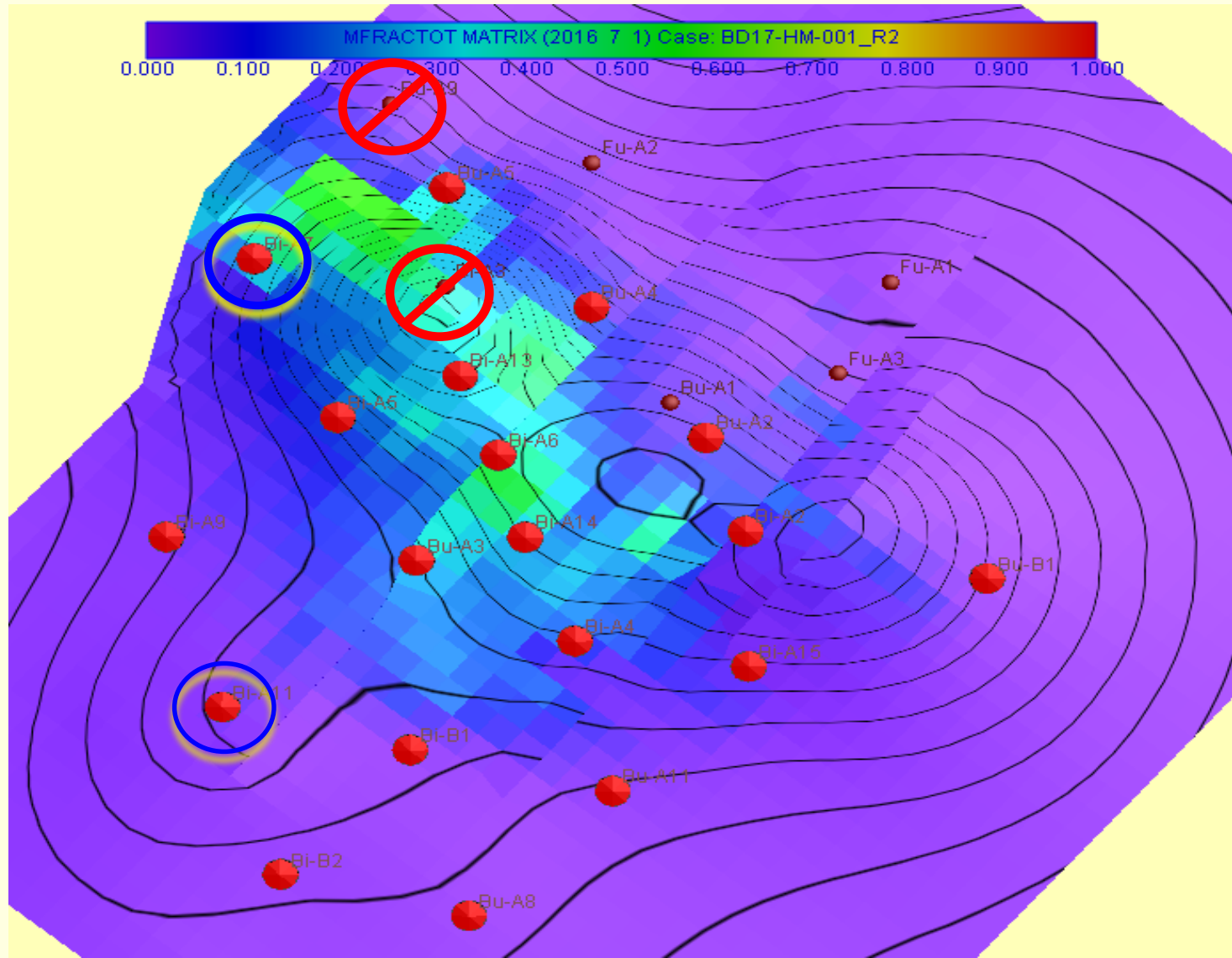
## Water encroachment



# Reservoir Status 2017



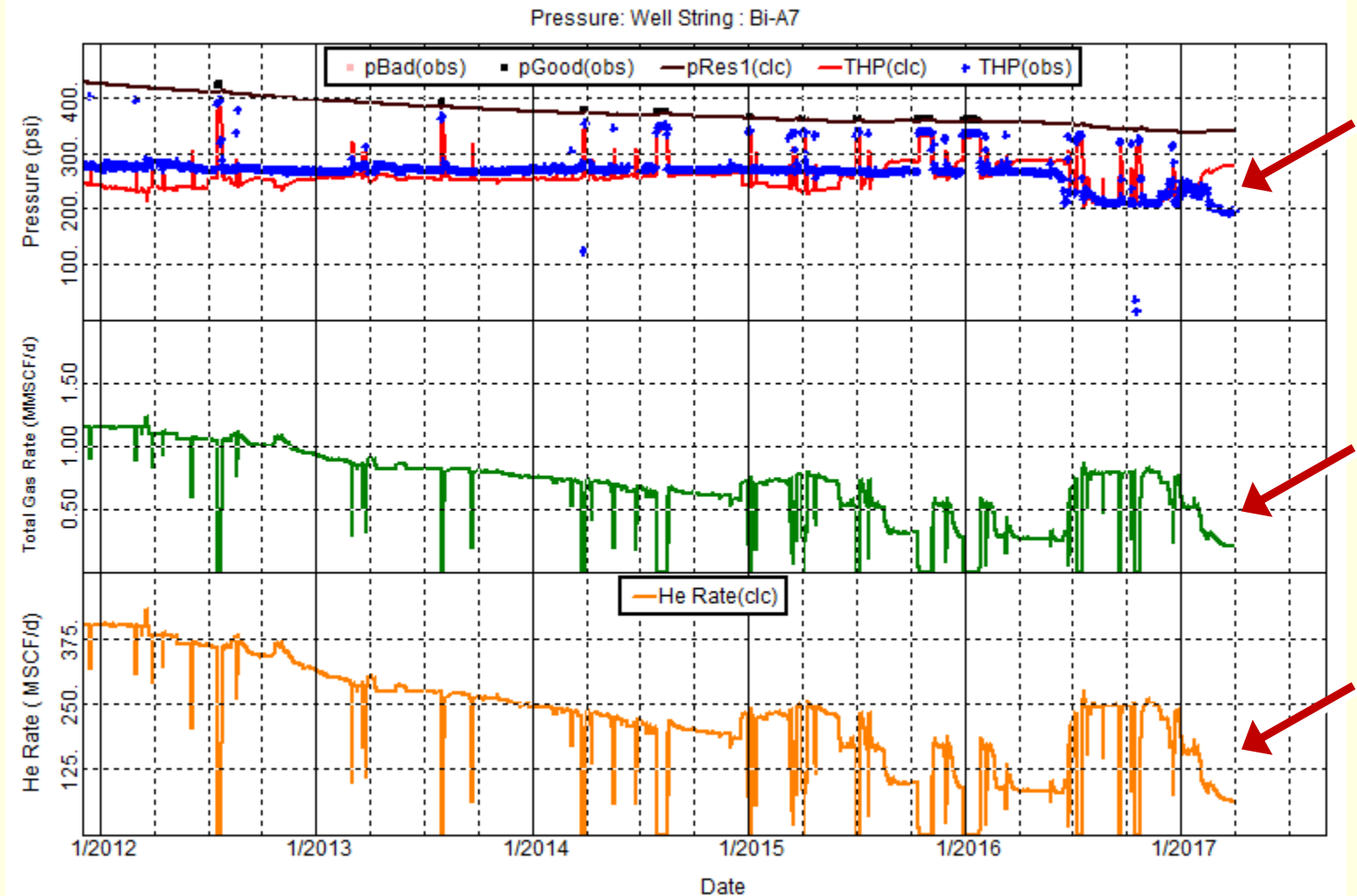
## ■ Water encroachment



# Reservoir Status 2017



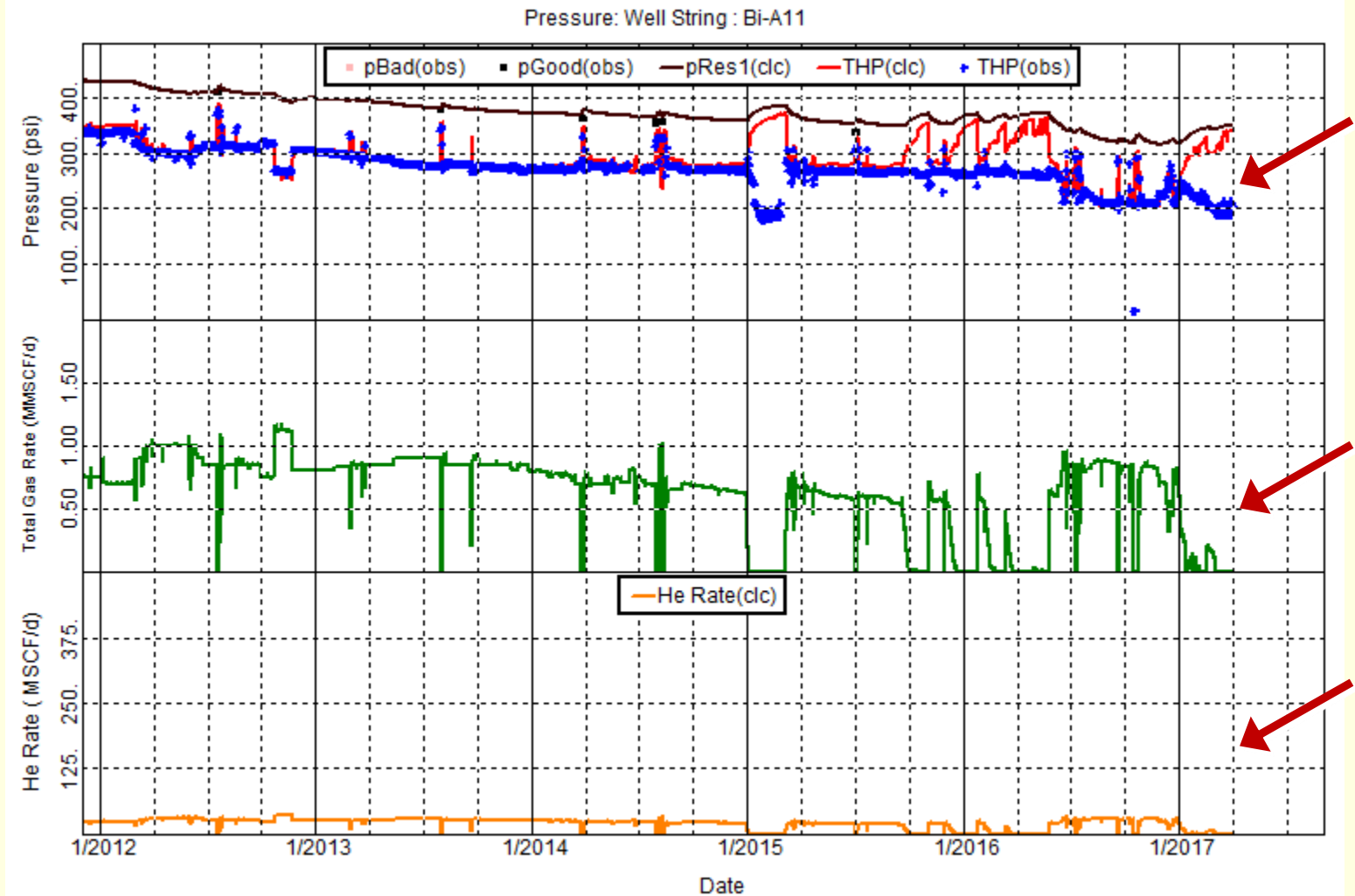
## Water encroachment – Bi-A7



# Reservoir Status 2017



## Water encroachment – Bi-A11





## ■ Conclusions

- **Field is at max total gas / max helium until compression issues are resolved (K100 modification and/or Central Compression)**
- **Currently in a high He demand period, field flowing at/near maximum ability, Total gas and He rates will decline over time until min flowing pressure is addressed.**
- **He concentration below 45% for all wells**
- **Water encroachment impacting more wells  
Except for Bi-A7, water encroachment in outer wells will only have a small impact on helium production, but does impact methane for startup**

# Outline



- *Reservoir Status (Operations: 2016-2017)*
- *Simulation Model Status*
- *Predictions*
- *Conclusions*



*Tour de France - 2017*

# Simulation Model Status- 2017



- No changes to model in 2016-17 update
- Updated rates and pressures for 2016-17:
  - Helium match:
    - Field Level: 100.7% of 2016-17 He produced  
Annual volume: 1.052 vs. 1.060 Bcf (measured vs. model)
    - Most wells (19 of 22) within +/- 3% (very good+)
    - The problem wells showed some increase with mismatch on He%, but their mismatch balance each other, one is high, the other low.
  - Pressure match:
    - Very good to excellent reservoir pressure match



# Simulation Model Status- 2017



- Q: How accurate is the simulation model ?
  - Field Level – most important for He forecast
    - Very good history match on pressure and He Prod
    - Previous predictions track well with historical trends
    - Predictions should be within +/- 5%, for next few years
  - Well Level – key wells very important
    - Very good match on pressure and He Prod, but more variability
    - Decline trend match for He is also very good
    - 2 wells have weaker He match
    - Mismatches are balanced between wells (Field match)
  - Examples

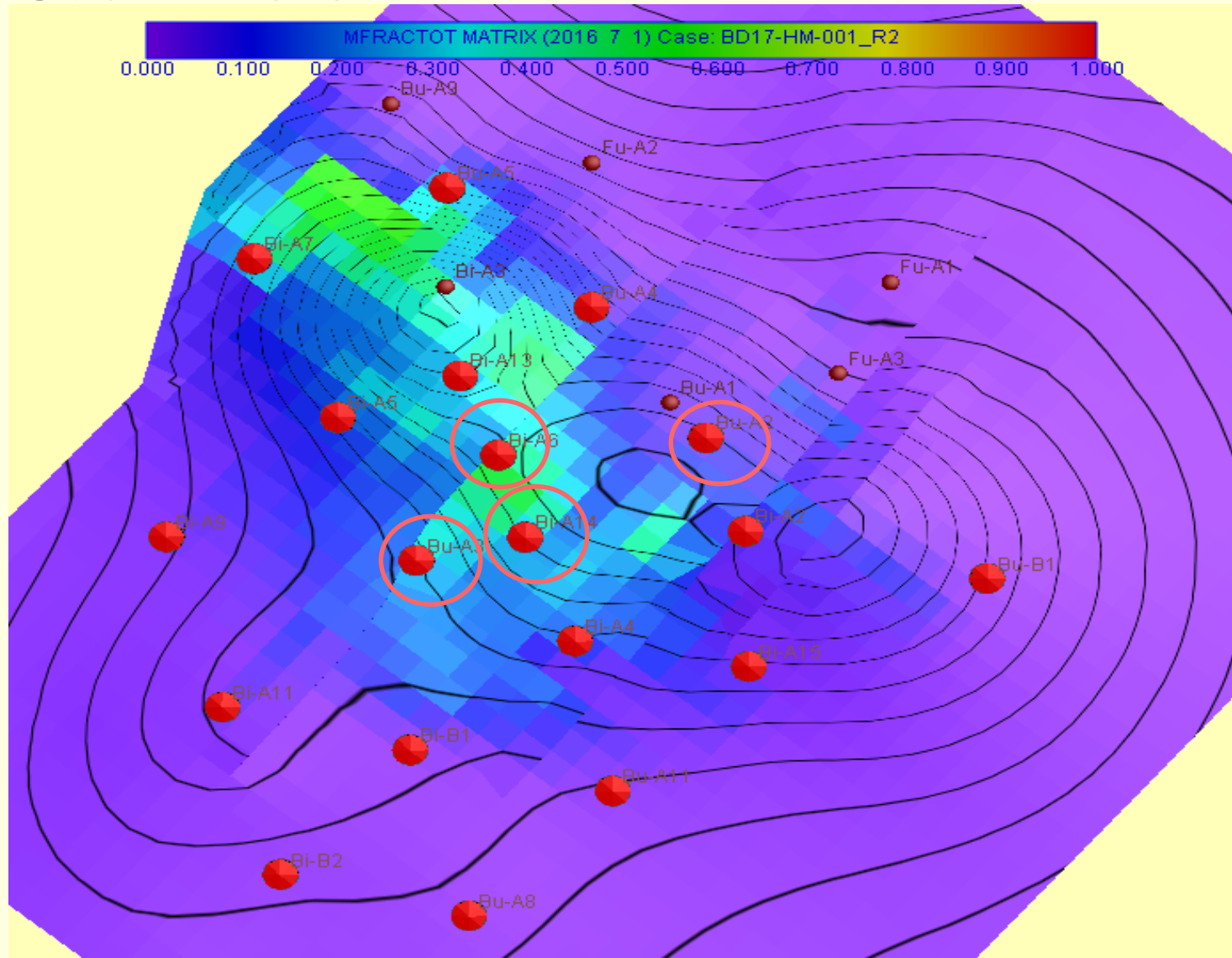


- Examples – History Match Graphs
  - South Wells
    - Bi-A6 – Best producing well, He Injection
    - Bi-A14 – 2<sup>nd</sup> best producing
    - Bu-A2 – Shows significant methane invasion
    - Bu-A3 – weaker match on He concentration (-8%)

# Simulation Model Status - 2017



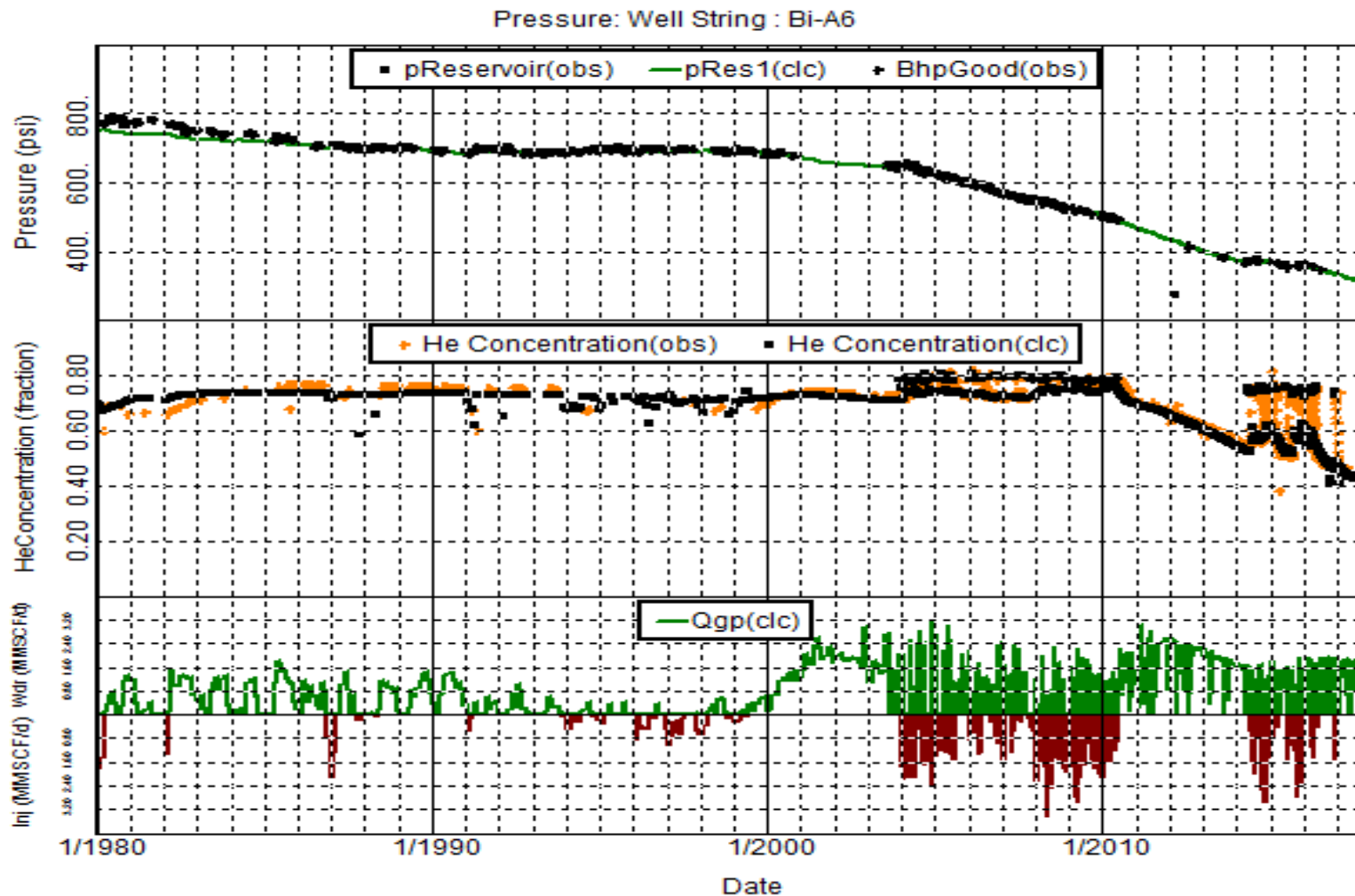
## ■ South Wells



# Simulation Model Status - 2017



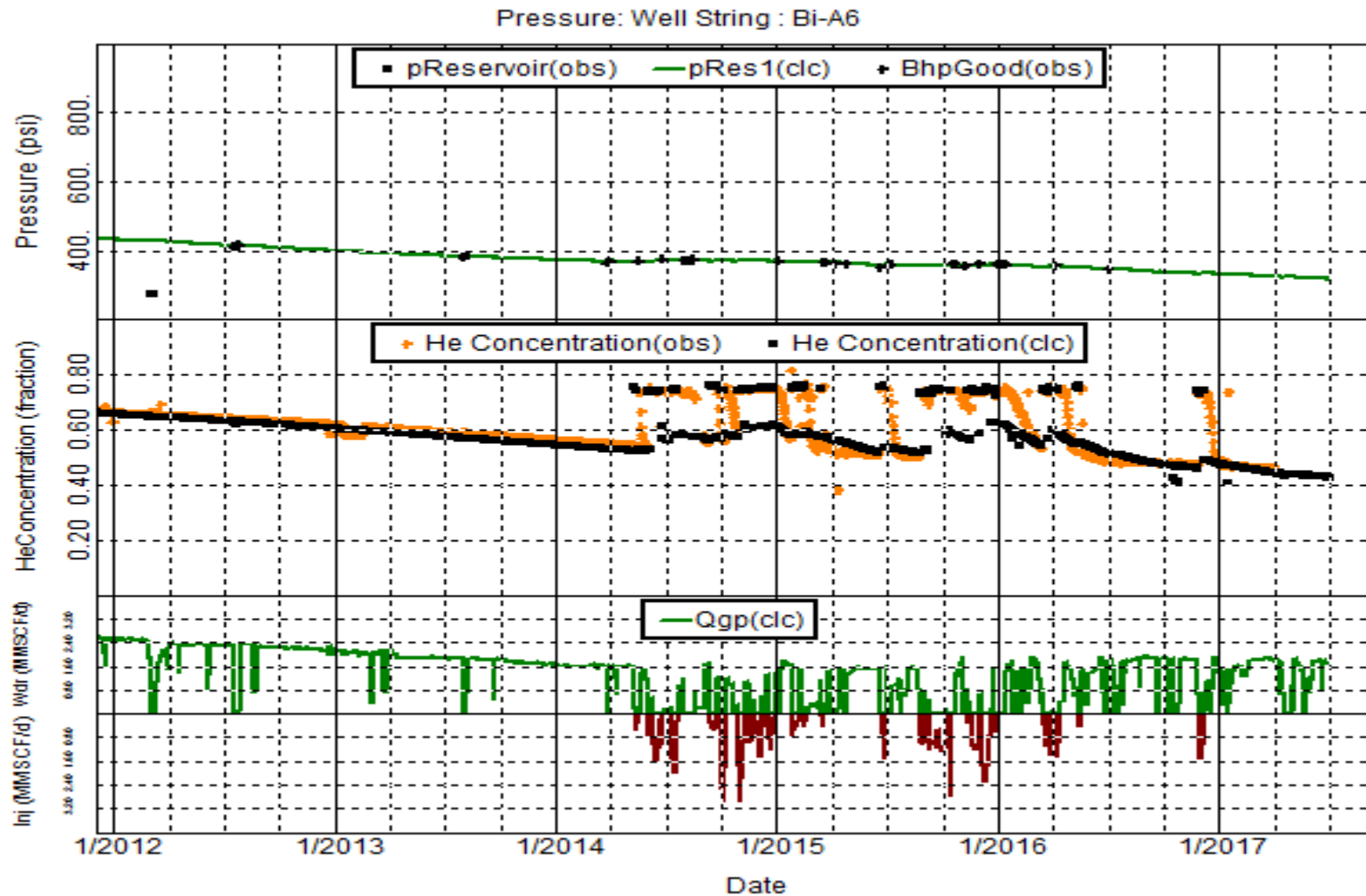
## ■ HM Plot – Bi-A6 (South Well)



# Simulation Model Status - 2017



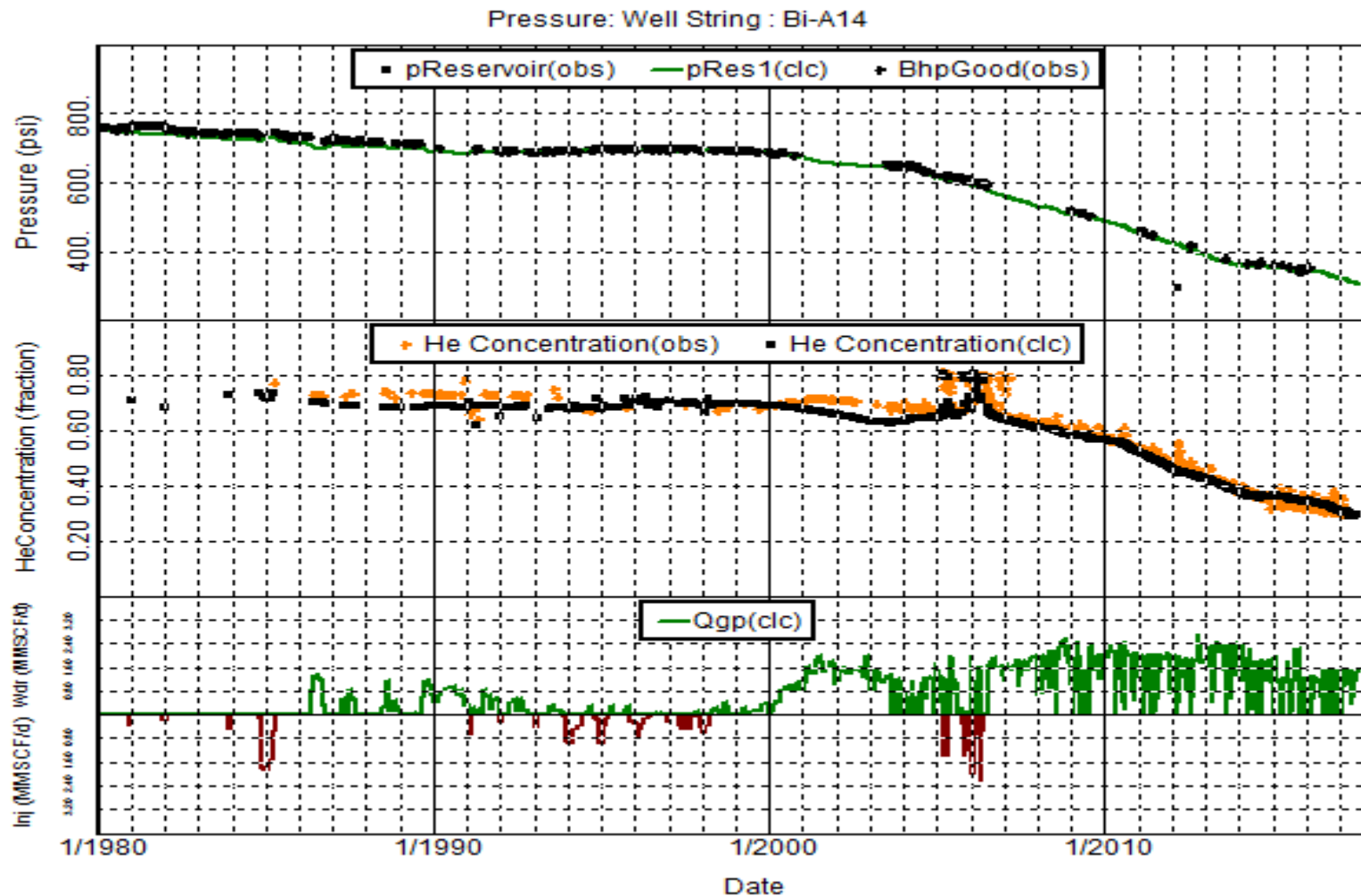
## ■ HM Plot – Bi-A6 (South Well)



# Simulation Model Status - 2017



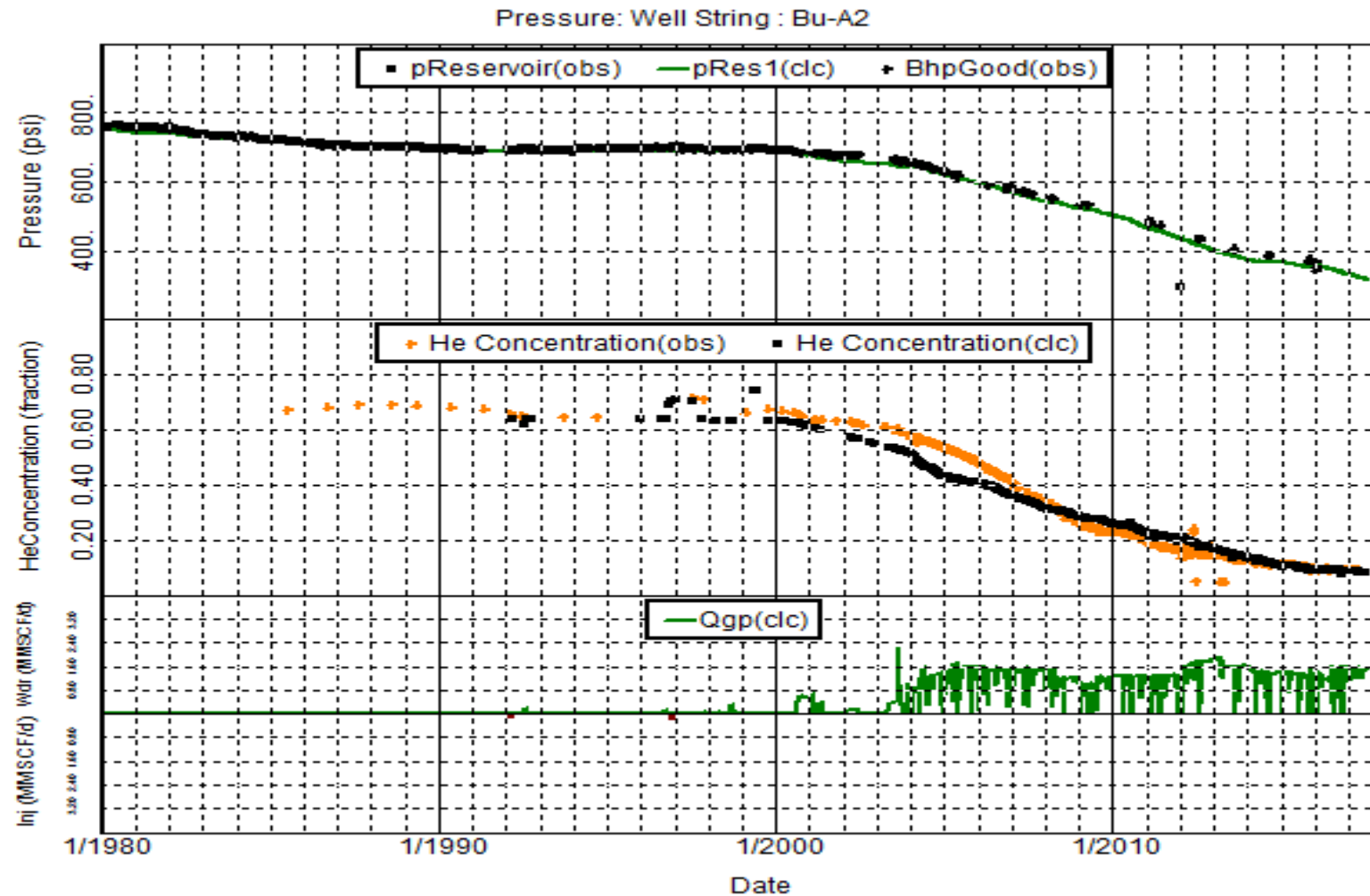
## ■ HM Plot – Bi-A14 (South Well)



# Simulation Model Status - 2017



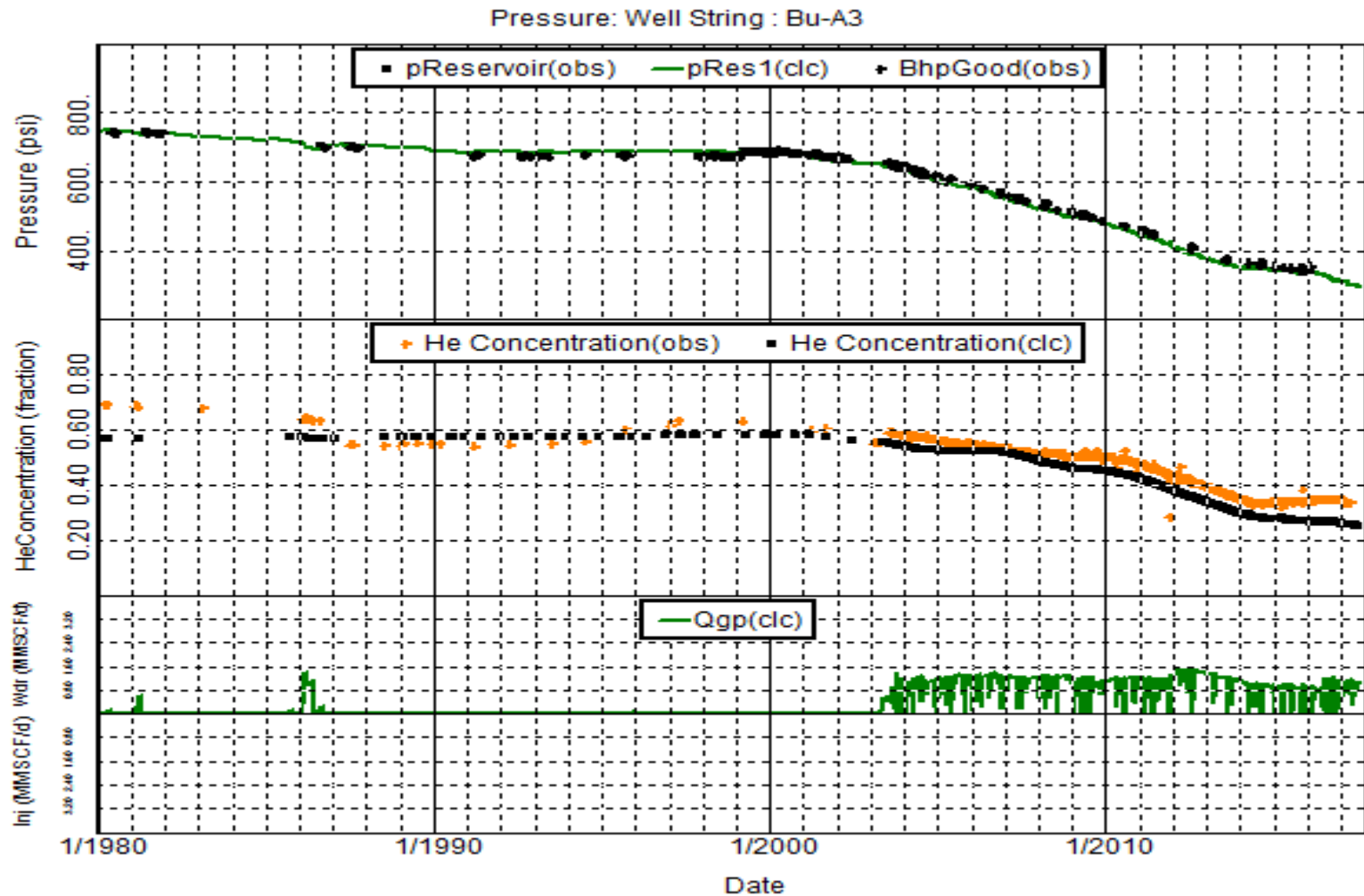
## ■ HM Plot – Bu-A2 (South Well)



# Simulation Model Status - 2017



## ■ HM Plot – Bu-A3 (South Well)

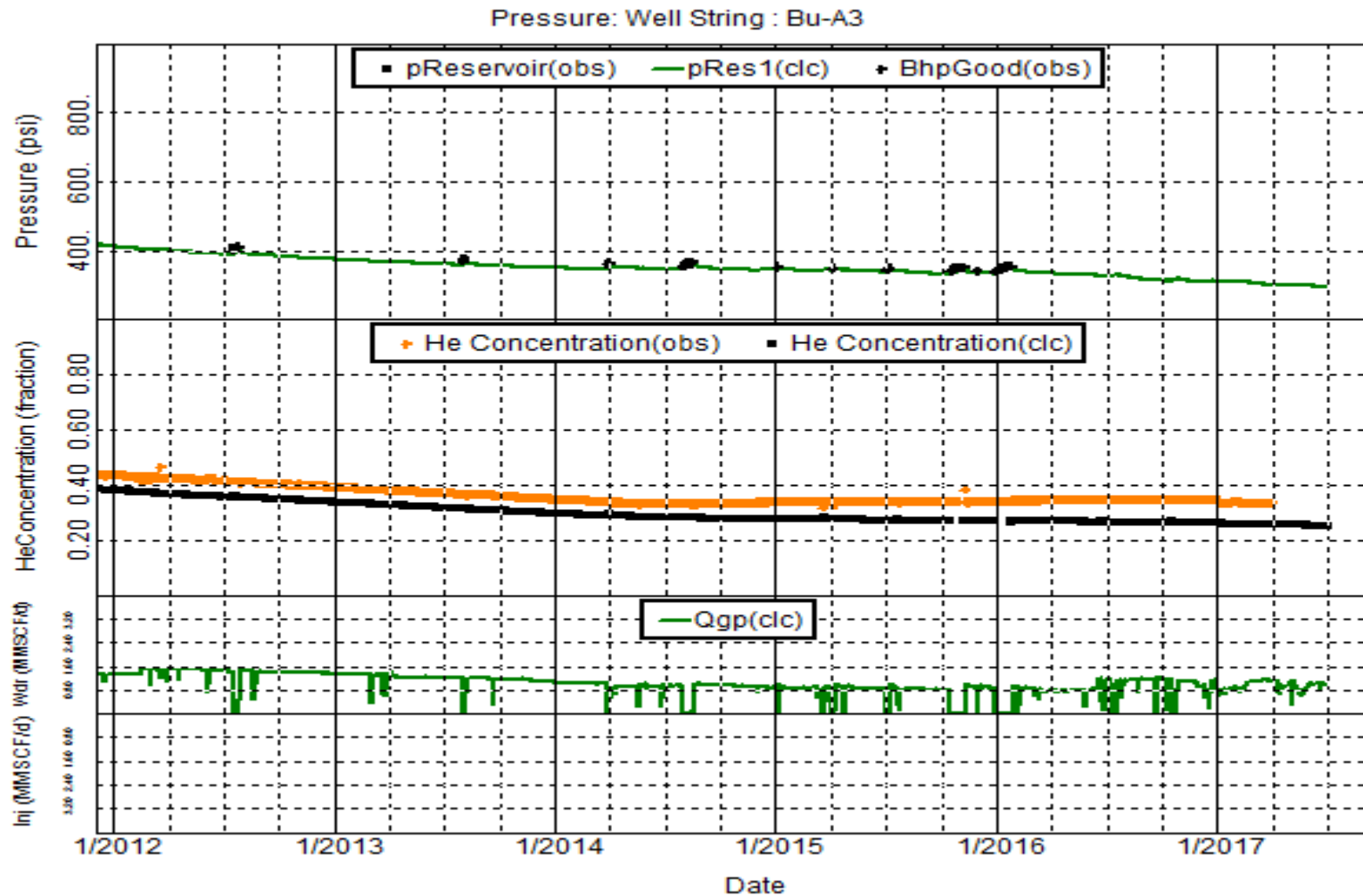




# Simulation Model Status - 2017



## ■ HM Plot – Bu-A3 (South Well)





## ■ Examples – History Match Graphs

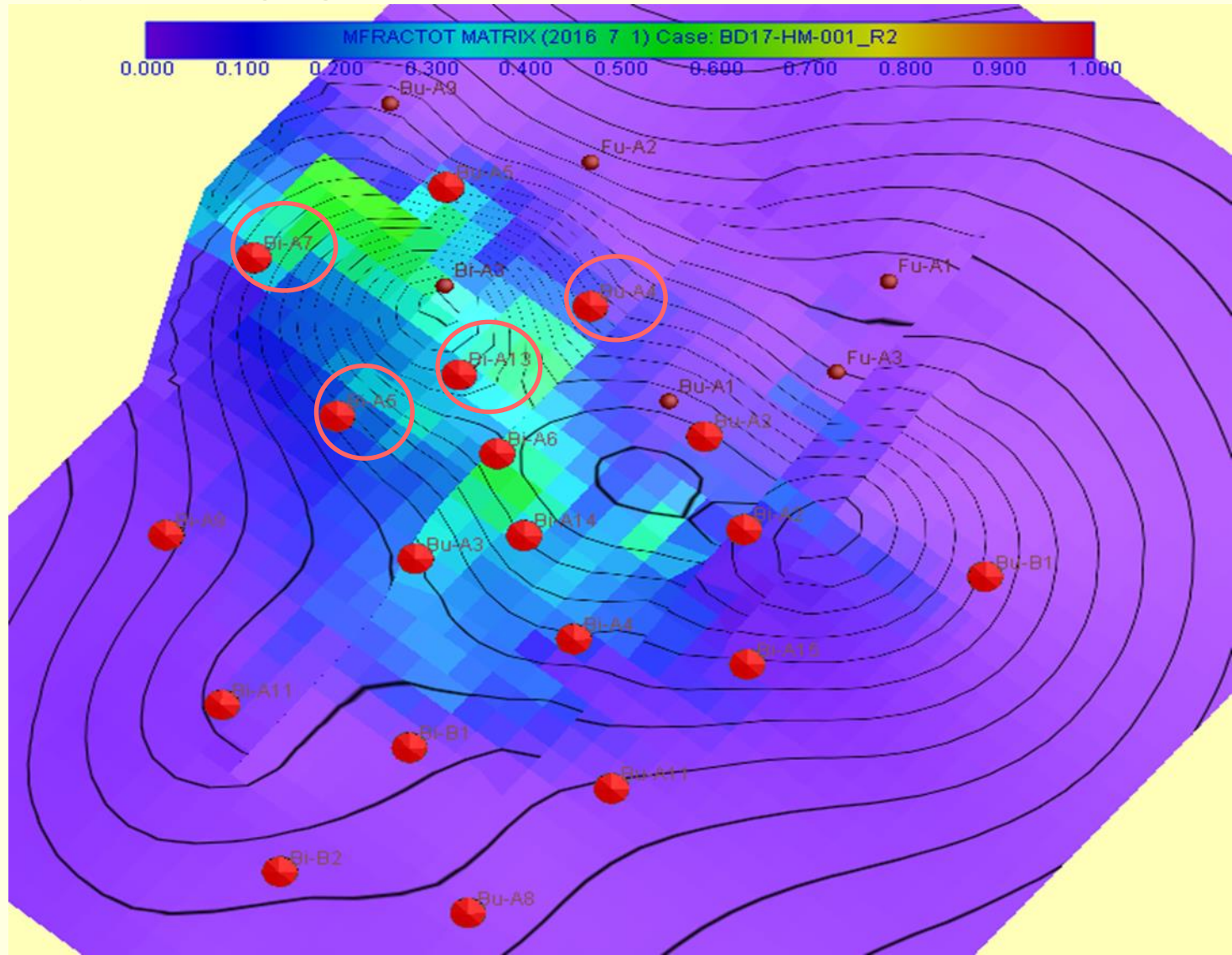
### ■ North Wells

- Bi-A13 – Best producing well in north area
- Bi-A7 – Good He concentration, water issue
- Bu-A4 – Weaker match on He concentration (+8%)
- Bi-A5 – Improved match on He conc. vs 2016 (-3%)

# Simulation Model Status - 2017



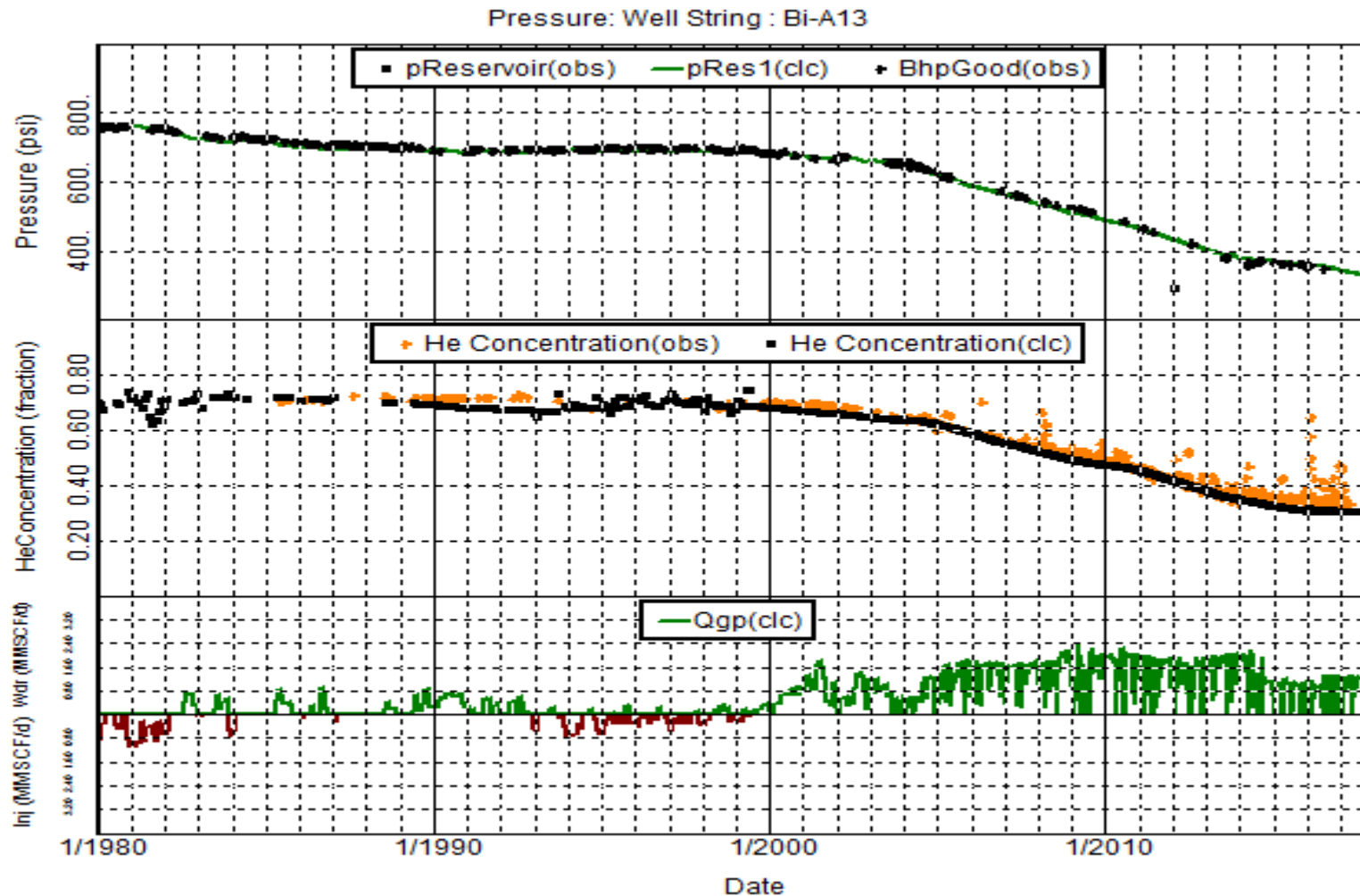
## ■ North Wells



# Simulation Model Status - 2017



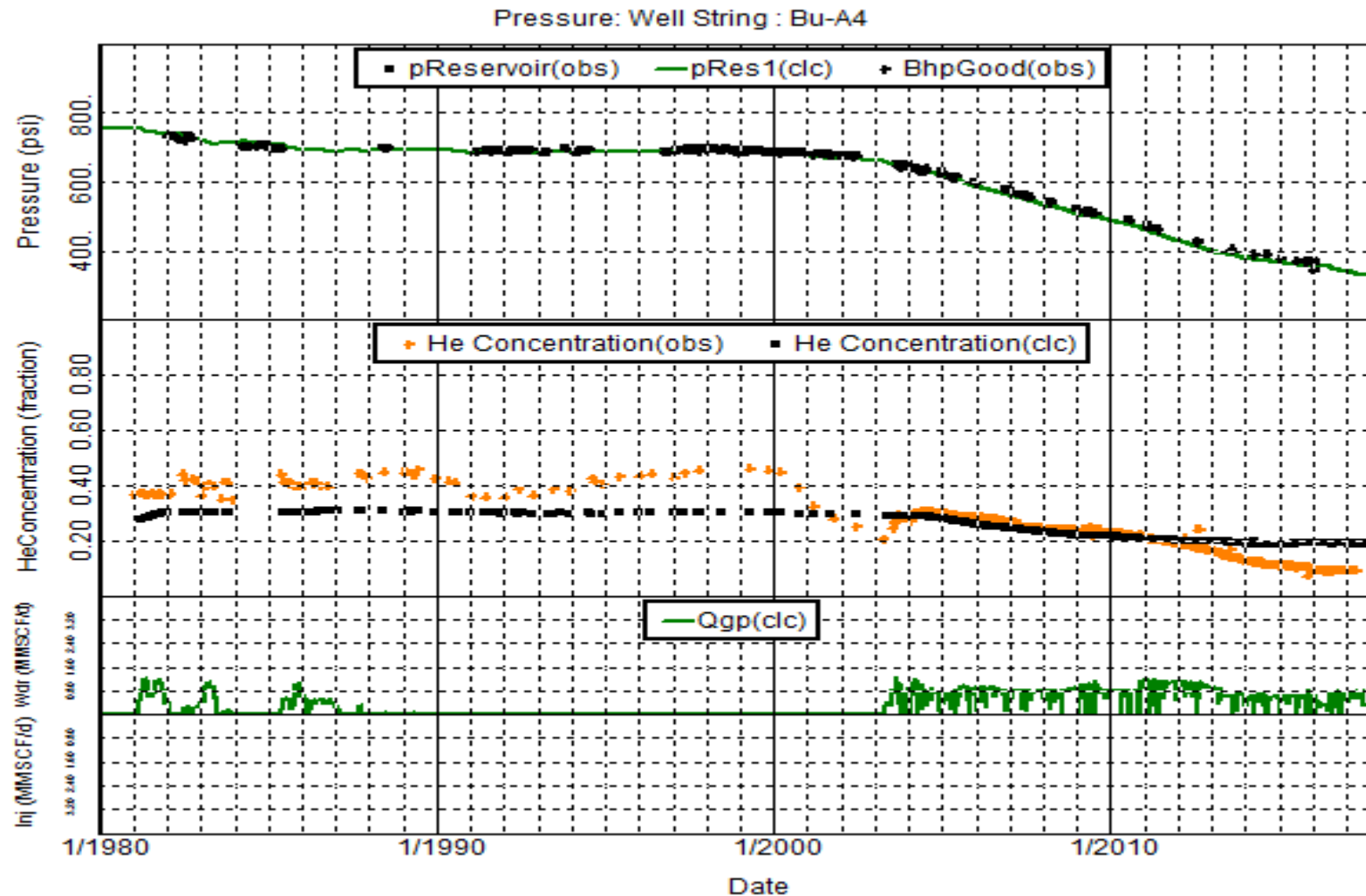
## ■ HM Plot – Bi-A13 (North Well)



# Simulation Model Status - 2017



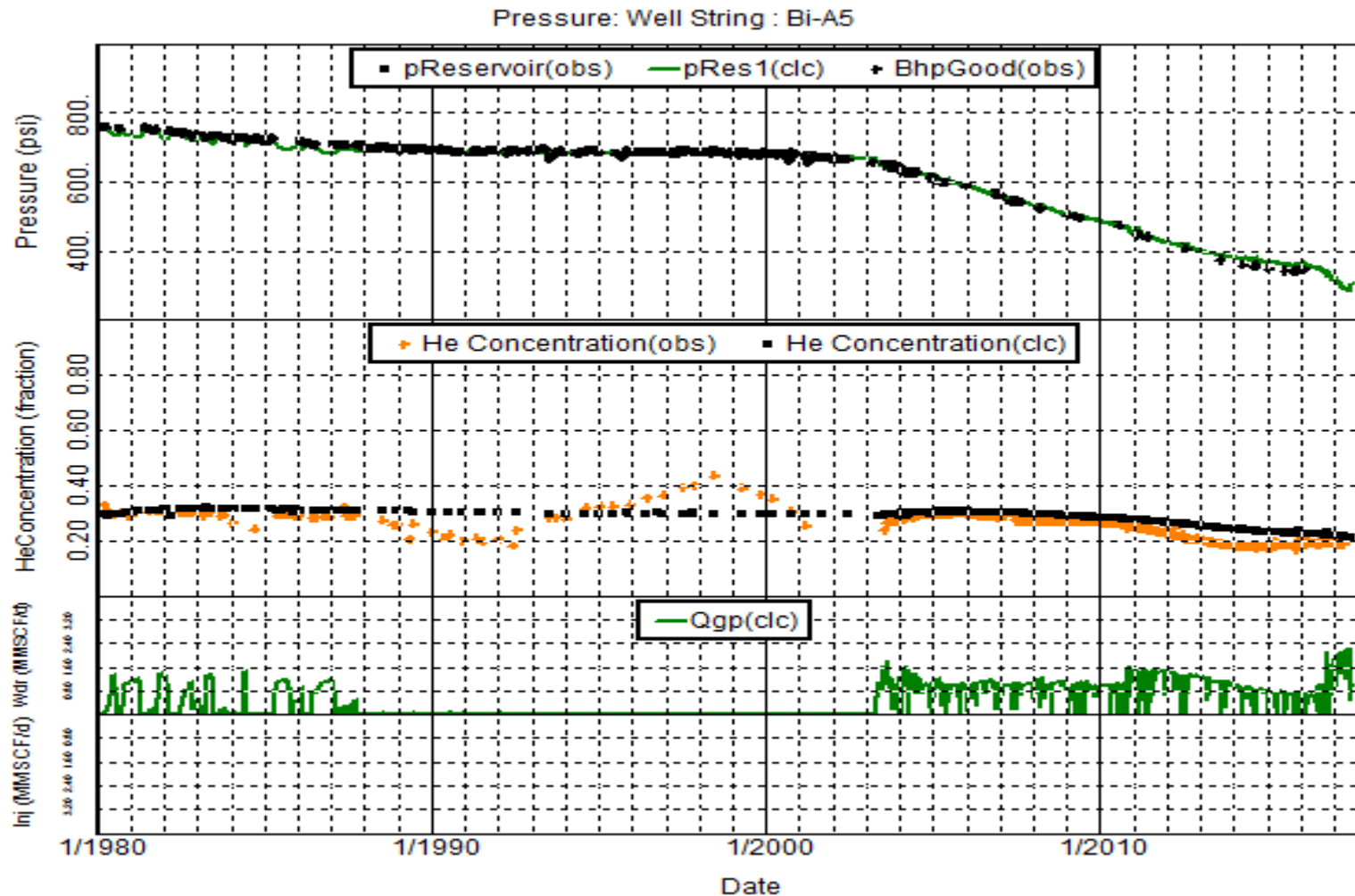
## ■ HM Plot – Bu-A4 (North Well)



# Simulation Model Status - 2017



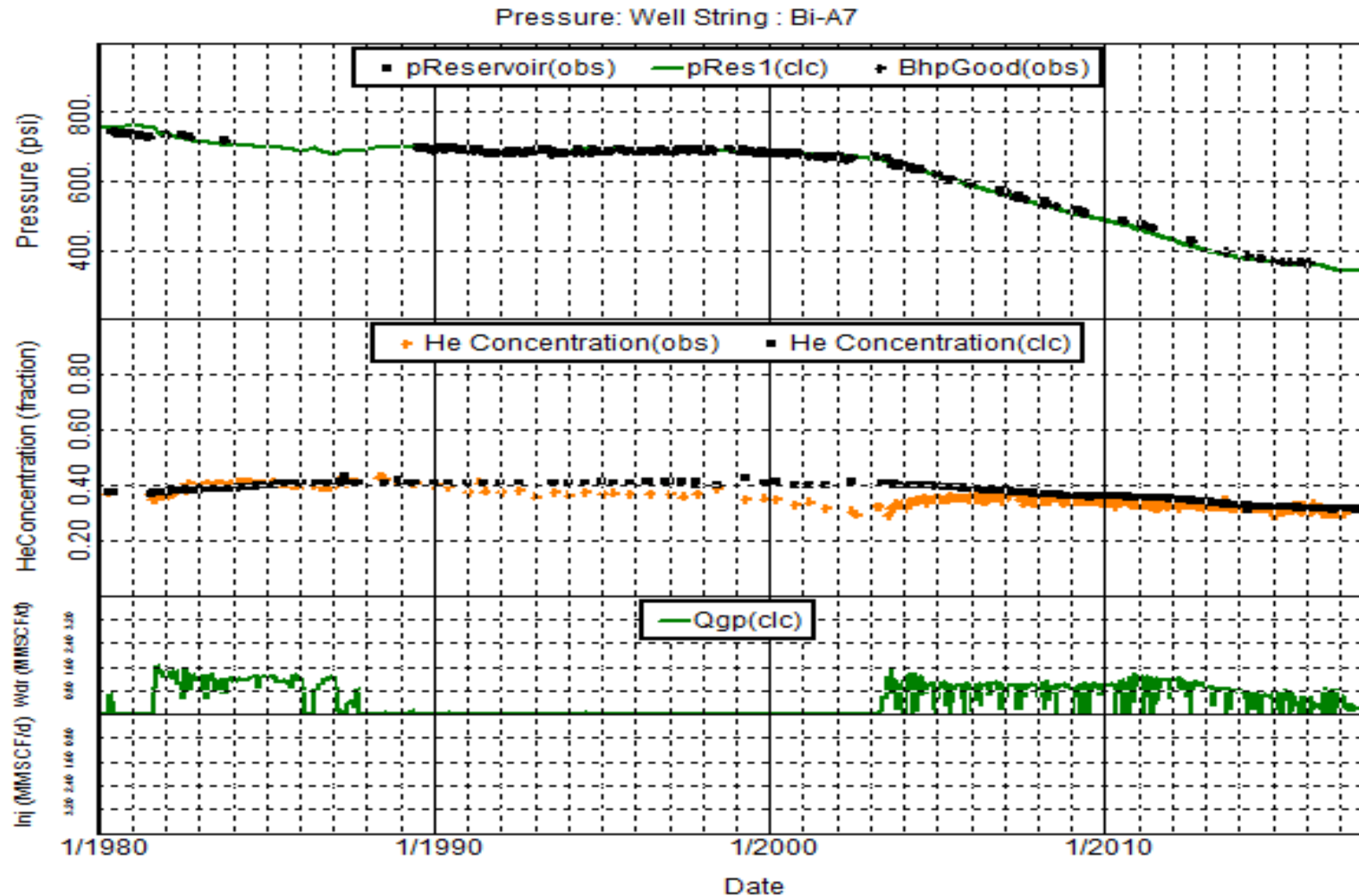
## ■ HM Plot – Bi-A5 (North Well)



# Simulation Model Status - 2017



## ■ HM Plot – Bi-A7 (North Well)





## ■ Conclusions

- Model shows very good-excellent match at field level for helium rate, concentrations and pressure
- Individual well match on helium rate / fraction shows wider variations, but averages out at field level
- Some changes in measured water production. Model is OK-good water match
  - Outer edge wells on east produce more water in the model than measured.
  - Other wells show good water match
  - Water match for Bi-A7 needs improvement



# Implications on Predictions - 2017



- Helium Rate / Fraction
  - Expect model will continue with same level of accuracy VG-Excellent at Field level (Total Gas and He Rate)
- Water Encroachment
  - Provides indications of effects of water encroachment.
  - At this time the model does not accurately predict which wells could be shut-in due to water encroachment and low flow rates.
  - The model can not predict the sudden water breakthroughs due to unidentified fracture connections.

# Outline



- *Reservoir Status (Operations: 2015-2016)*
- *Reservoir History & Life Cycle (Depletion)*
- *Simulation Model Status*
- ***Predictions***
- *Conclusions*



*Tour de France - 2017*

# Prediction Cases 2017



- Prediction objectives:
  - Determine maximum possible annual helium production from July 1, 2017 – Sep 30 2021
  - Evaluate impact of low helium demand
  - Estimate helium recovery post 2021

# Prediction Cases 2017



## ■ Results

- *Preliminary results to assist with future planning. Prediction results will be reviewed with BLM.*
- *Final annual sales volumes will be determined by BLM based on the remaining government inventory, in-kind requirements, HSA-2013 mandates, predicted production volumes, and consideration of other relevant factors.*

# Prediction Cases 2017



## ■ Results

- *Note: all results are simulation model estimates, indicating the future trends.*
- *These predictions do not take into account production changes or future operational issues that can occur in any gas production field – such as (but not limited to)*
  - *Changes in He demand*
  - *Well damage/flow issues, water encroachment*
  - *Surface facility issues, upgrades, repairs....*

# Prediction Cases 2017



## ■ Prediction cases

### ■ Case 1: Current operations

- Pmin for all wells = 192 psia
- Maximum well rates (max He rate)

### ■ Case 2: Central compression online 10/15/2017

- Pmin = 75 psia
- Maximum well rates (max He rate)

### ■ Case 3: Low Rate till 9/2021

- Pmin for all wells = 75 psia
- 12 MM/d at 11% He 10/2017 to 9/2021

### ■ All Cases: Maximum well rates 9/2021 to 9/2029

# Prediction Cases 2017



## ■ Results

### ■ Case comparisons

- Graphs with rates and cumulative volumes
- Tables with rates and cumulative volumes

# Prediction Cases 2017



## ■ Case 1 Current Conditions – (Pmin 192 psia)

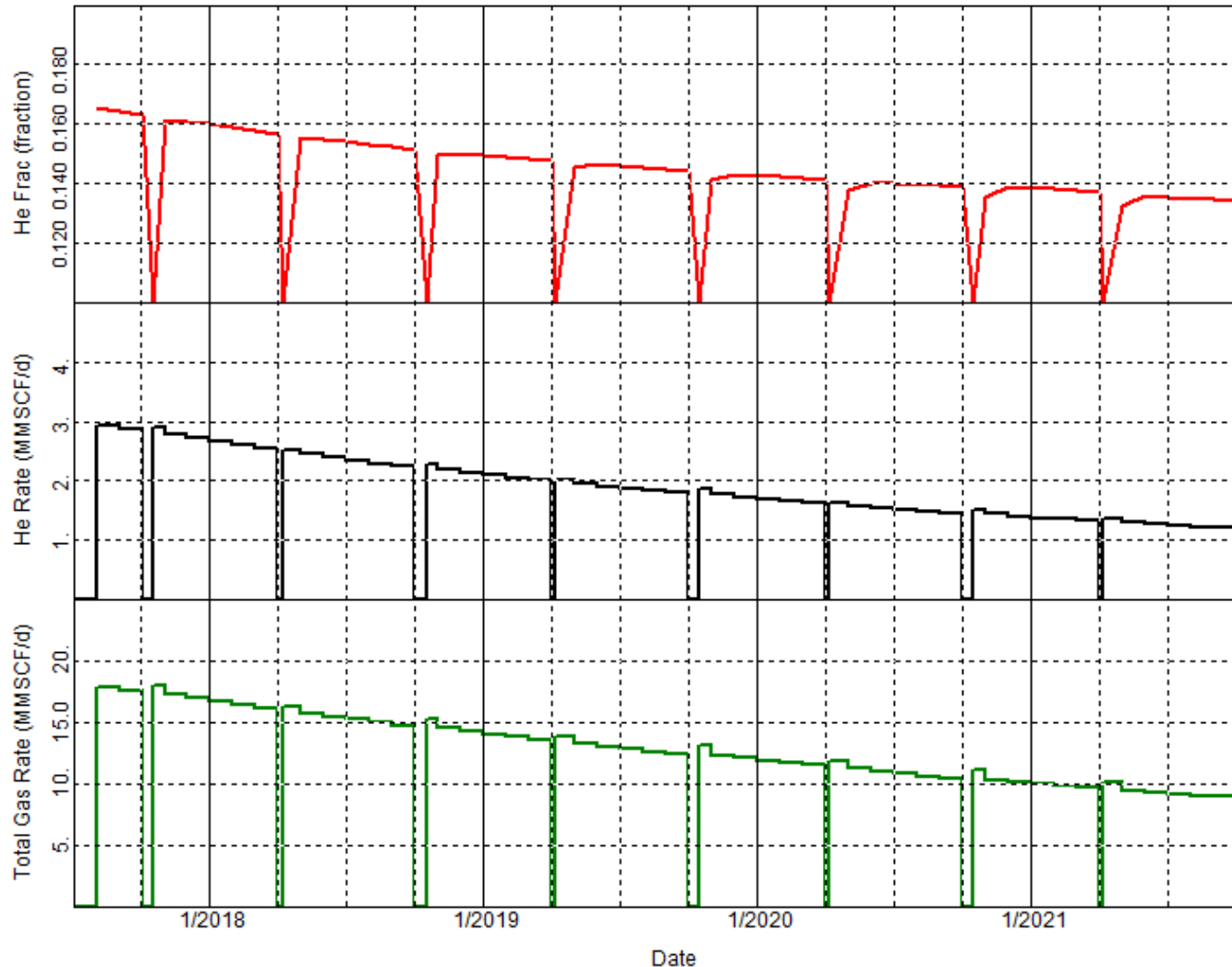
### Annual Helium Vol (BCF)

| FY      | Case 1 |
|---------|--------|
| 2017    | 0.256  |
| 2018    | 0.825  |
| 2019    | 0.656  |
| 2020    | 0.532  |
| 2021    | 0.433  |
| '17-'21 | 2.702  |

### Annual Total Gas Vol (BCF)

| FY      | Case 1 |
|---------|--------|
| 2017    | 1.559  |
| 2021    | 5.268  |
| 2022    | 4.451  |
| 2023    | 3.774  |
| 2024    | 3.177  |
| '17-'21 | 18.229 |

Gas Production/Injection Rate: Total System





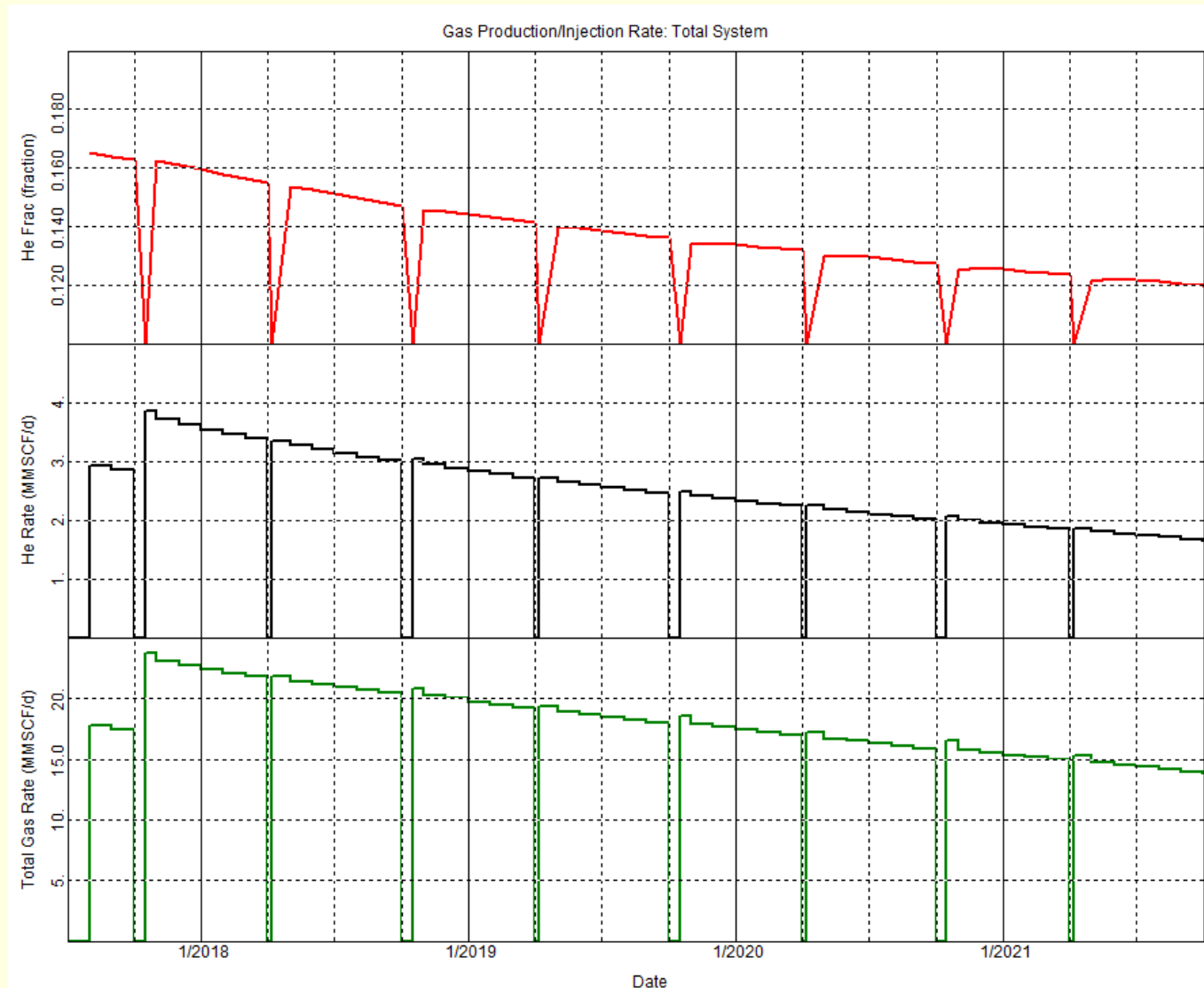
# Prediction Cases 2017



## ■ Case 2 Central Compressor – 10/15/17 (Pmin 75 psia)

| Annual Helium Vol (BCF) |        |
|-------------------------|--------|
| FY                      | Case 2 |
| 2017                    | 0.256  |
| 2018                    | 1.107  |
| 2019                    | 0.890  |
| 2020                    | 0.735  |
| 2021                    | 0.607  |
| '17-'21                 | 3.595  |

| Annual Total Gas Vol (BCF) |        |
|----------------------------|--------|
| FY                         | Case 2 |
| 2017                       | 1.559  |
| 2018                       | 7.156  |
| 2019                       | 6.307  |
| 2020                       | 5.590  |
| 2021                       | 4.917  |
| '17-'21                    | 25.529 |



# Prediction Cases 2017



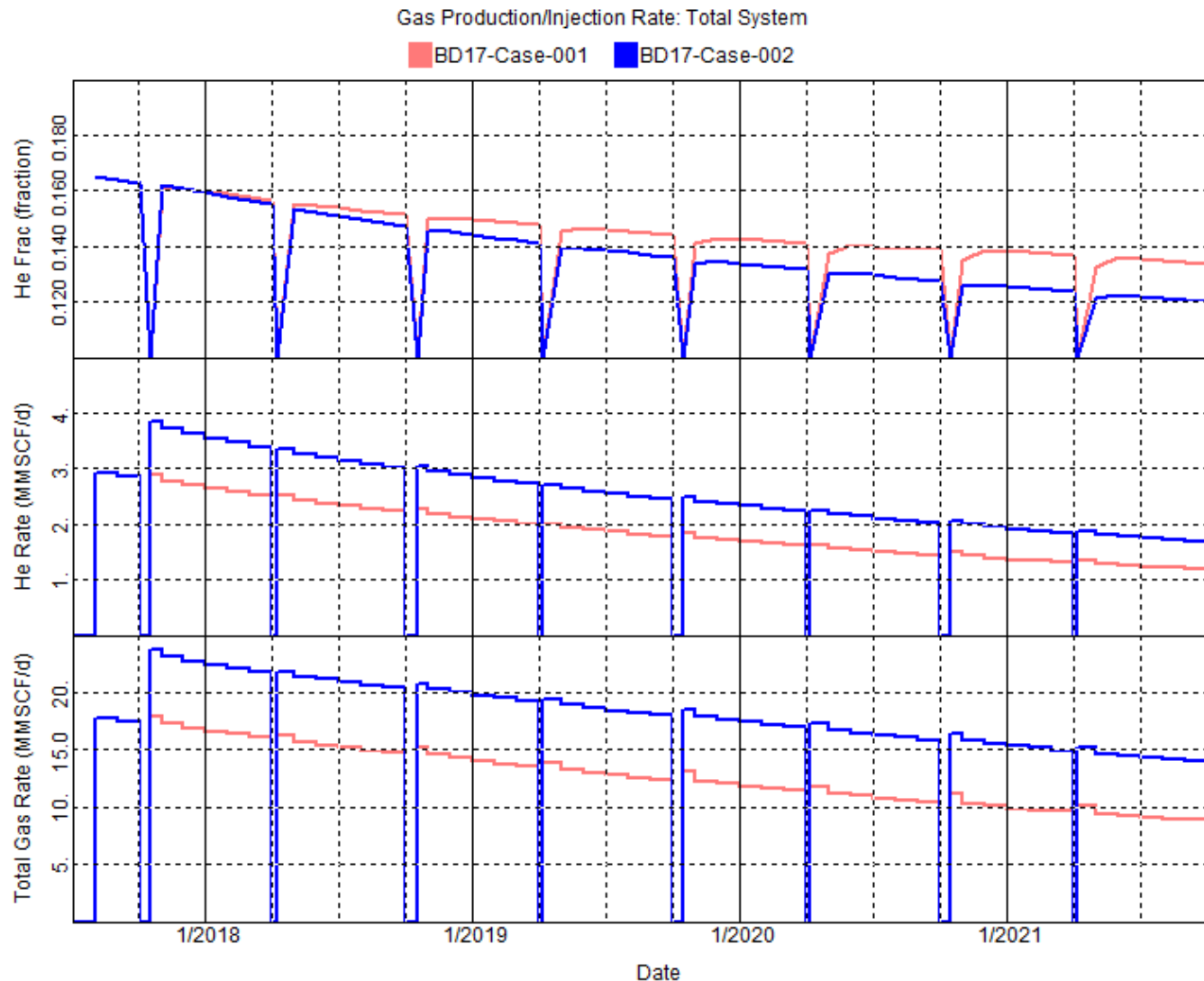
## Case 1 & 2 Comparison

### Annual Helium Vol (BCF)

| FY      | Case 1 | Case 2 |
|---------|--------|--------|
| 2017    | 0.256  | 0.256  |
| 2018    | 0.825  | 1.107  |
| 2019    | 0.656  | 0.890  |
| 2020    | 0.532  | 0.735  |
| 2021    | 0.433  | 0.607  |
| '17-'21 | 2.702  | 3.595  |

### Annual Total Gas Vol (BCF)

| FY      | Case 1 | Case 2 |
|---------|--------|--------|
| 2017    | 1.559  | 1.559  |
| 2018    | 5.268  | 7.156  |
| 2019    | 4.451  | 6.307  |
| 2020    | 3.774  | 5.590  |
| 2021    | 3.177  | 4.917  |
| '17-'21 | 18.229 | 25.529 |



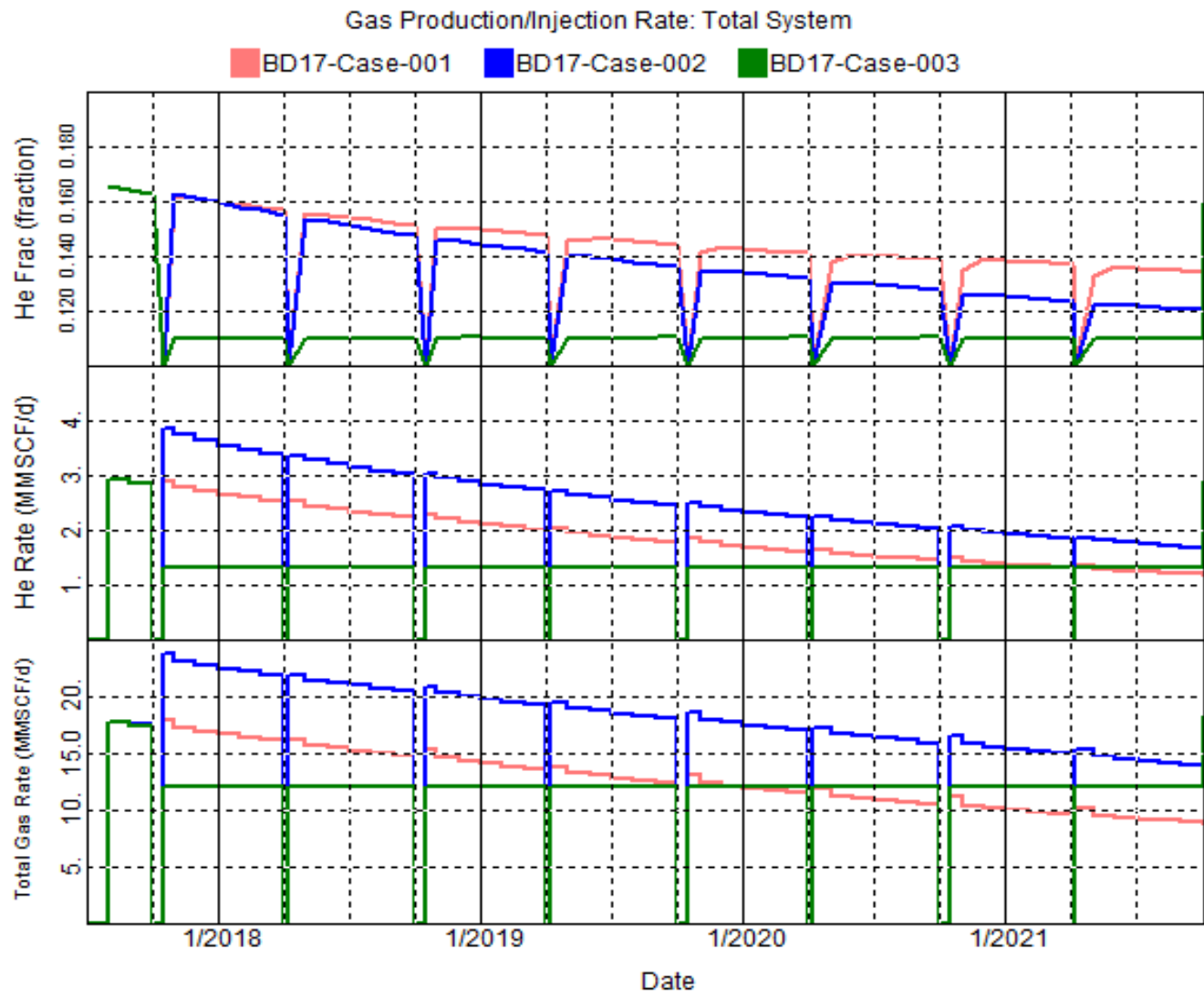
# Prediction Cases 2017



- Case 3 Low Rate – 12 MM/d Total Gas, 1.320 MM/d He

| Annual Helium Vol (BCF) |        |        |        |
|-------------------------|--------|--------|--------|
| FY                      | Case 1 | Case 2 | Case 3 |
| 2017                    | 0.256  | 0.256  | 0.256  |
| 2018                    | 0.825  | 1.107  | 0.453  |
| 2019                    | 0.656  | 0.890  | 0.434  |
| 2020                    | 0.532  | 0.735  | 0.436  |
| 2021                    | 0.433  | 0.607  | 0.434  |
| '17-'21                 | 2.702  | 3.595  | 2.013  |

| Annual Total Gas Vol (BCF) |        |        |        |
|----------------------------|--------|--------|--------|
| FY                         | Case 1 | Case 2 | Case 3 |
| 2017                       | 1.559  | 1.559  | 1.559  |
| 2018                       | 5.268  | 7.156  | 4.112  |
| 2019                       | 4.451  | 6.307  | 3.936  |
| 2020                       | 3.774  | 5.590  | 3.949  |
| 2021                       | 3.177  | 4.917  | 3.935  |
| '17-'21                    | 18.229 | 25.529 | 17.492 |



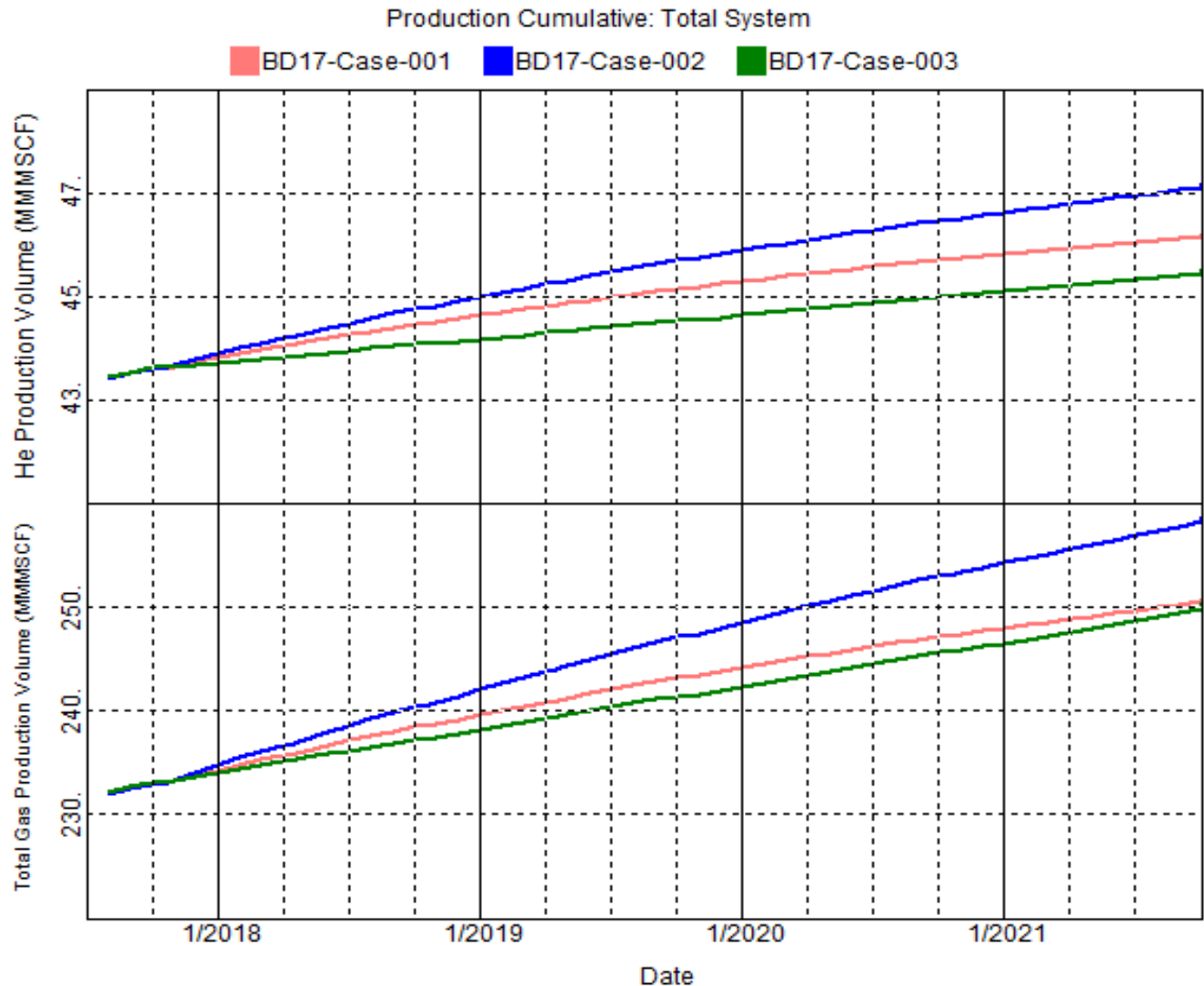
# Prediction Cases 2017



## ■ Total Production July 2017 – Sep 30 2021

| Cumulative Helium Vol (BCF) |        |        |        |
|-----------------------------|--------|--------|--------|
| FY                          | Case 1 | Case 2 | Case 3 |
| 2017                        | 0.256  | 0.256  | 0.256  |
| 2018                        | 1.081  | 1.363  | 0.709  |
| 2019                        | 1.737  | 2.253  | 1.143  |
| 2020                        | 2.269  | 2.988  | 1.579  |
| 2021                        | 2.702  | 3.595  | 2.013  |
| '17-'21                     | 2.702  | 3.595  | 2.013  |

| Cumulative Total Gas Vol (BCF) |        |        |        |
|--------------------------------|--------|--------|--------|
| FY                             | Case 1 | Case 2 | Case 3 |
| 2017                           | 1.559  | 1.559  | 1.559  |
| 2018                           | 6.827  | 8.715  | 5.671  |
| 2019                           | 11.278 | 15.022 | 9.608  |
| 2020                           | 15.052 | 20.612 | 13.556 |
| 2021                           | 18.229 | 25.529 | 17.492 |
| '17-'21                        | 18.229 | 25.529 | 17.492 |



# Prediction Cases 2017



## Helium Production

| Annual Production - 95%           |              |              |               |
|-----------------------------------|--------------|--------------|---------------|
| Helium Produced Since July 1 2017 |              |              |               |
|                                   | Case 1       | Case 2       | Case 3        |
|                                   | Current      | CC 10/2017   | Low Rate      |
| (1st of mth)                      | (Bcf)        | (Bcf)        | (Bcf)         |
| Oct-2017                          | 0.256        | 0.256        | 0.256         |
| Oct-2018                          | 0.825        | 1.107        | 0.453         |
| Oct-2019                          | 0.656        | 0.890        | 0.434         |
| Oct-2020                          | 0.532        | 0.735        | 0.436         |
| Oct-2021                          | <b>0.433</b> | <b>0.607</b> | <b>0.434</b>  |
| Cumulative Production - 95%       |              |              |               |
| Helium Produced Since July 1 2017 |              |              |               |
|                                   | Case 1       | Case 2       | Case 3        |
|                                   | Current      | CC 10/2017   | Low Rate      |
| (1st of mth)                      | (Bcf)        | (Bcf)        | (Bcf)         |
| Oct-2017                          | 0.256        | 0.256        | 0.256         |
| Oct-2018                          | 1.081        | 1.363        | 0.709         |
| Oct-2019                          | 1.737        | 2.253        | 1.143         |
| Oct-2020                          | 2.269        | 2.988        | 1.579         |
| Oct-2021                          | <b>2.702</b> | <b>3.595</b> | <b>2.013</b>  |
| <i>Difference between cases</i>   |              | <b>0.893</b> | <b>-1.582</b> |

# Prediction Cases 2017



## Total Gas Production

|                                 | Annual Production - 95%              |                      |                    |
|---------------------------------|--------------------------------------|----------------------|--------------------|
|                                 | Total Gas Produced Since July 1 2017 |                      |                    |
|                                 | Case 1<br>Current                    | Case 2<br>CC 10/2017 | Case 3<br>Low Rate |
| (1st of mth)                    | (Bcf)                                | (Bcf)                | (Bcf)              |
| Oct-2017                        | 1.559                                | 1.559                | 1.559              |
| Oct-2018                        | 5.268                                | 7.156                | 4.112              |
| Oct-2019                        | 4.451                                | 6.307                | 3.936              |
| Oct-2020                        | 3.774                                | 5.590                | 3.949              |
| Oct-2021                        | 3.177                                | 4.917                | 3.935              |
|                                 | Cumulative Production - 95%          |                      |                    |
|                                 | Total Gas Produced Since July 1 2017 |                      |                    |
|                                 | Case 1<br>Current                    | Case 2<br>CC 10/2017 | Case 3<br>Low Rate |
| (1st of mth)                    | (Bcf)                                | (Bcf)                | (Bcf)              |
| Oct-2017                        | 1.559                                | 1.559                | 1.559              |
| Oct-2018                        | 6.827                                | 8.715                | 5.671              |
| Oct-2019                        | 11.278                               | 15.022               | 9.608              |
| Oct-2020                        | 15.052                               | 20.612               | 13.556             |
| Oct-2021                        | 18.229                               | 25.529               | 17.492             |
| <i>Difference between cases</i> |                                      | <b>7.299</b>         | <b>-8.037</b>      |

# Outline



- *Reservoir Status (Operations: 2015-2016)*
- *Simulation Model Status*
- *Predictions*
- *Conclusions*



*Tour de France – 2017*

# Conclusions



## ■ Conclusions

- Producing with only the K100 modification will reduce the total He produced by 9/30/2021 by **-0.893 BCF** when compared to central compression online by Oct 2017 (*Case1*)
- With only the current K100 modification, the total gas rate will drop below 10 MM/d around January 2021, which may be less than the current HEU can process.
- Having central compression online by Oct 15 2017, will increase the total gas rate and He rate; the total He produced under this case is **3.595 BCF** (July 2017 – Sep 30 2021) (*Case2*)
- The low helium demand case will produce significant less helium (**-1.582 BCF**) by Sep 2021; the total He produced with this case is **2.015 BCF**



# Conclusions



## ■ Conclusions – Cases 1 & 2

- Predicted annual He volumes are the sum of the daily production rate, which is on *a constant decline* from the first day of the FY to the last day of the FY.
- Predicted production volumes represent the maximum volume of helium that *could be* delivered from the HEU;  
It does not equate to future helium sales  
*(determined by BLM)*  
or actual production volume  
*(determined by operations constraints & demand)*
- The *declining rates* will impact the volume per month of helium available for private industry, which will be the helium production volume less in-kind federal requirements through Sep 2021.

# Outline



- *Reservoir Status (Operations: 2015-2016)*
- *Simulation Model Status*
- *Predictions*
- *Conclusions*
- ***After Sept 30, 2021***



*Tour de France - 2017*

# After Sept 30, 2021



## ■ Disclaimers / Limitations

- *As of October 1, 2021, the US government will have transferred all delivery responsibilities to the purchasing entity. After the transfer, the US government will no longer be responsible for helium production/delivery from the Bush Dome Reservoir.*

# After Sept 30, 2021



## ■ Disclaimers / Limitations

- *All forecast results are simulation model estimates, indicating the future trends base upon the current model's history match.*
- *The estimated volumes in these predictions do not take into account possible changes in operations under new ownership.*
- *The estimated volumes assume that the produced gas mixture can be processed.*

# After Sept 30, 2021: Prediction Cases 2017



- Estimated Production Oct 1 2021– Sep 30 2029
  - Assumes maximum total gas and maximum helium rate
  - Assumes flowing well head pressure at 75 psia (Pmin)
  - Assumes all wells are able to flow, no water encroachment issues, no well integrity issues
- The model estimates that under the most optimistic conditions (Case 2, Max He), where private industry takes all the helium that can be produced from Oct 2017 – Sep 30 2021, the least amount of undelivered purchased helium gas will be ~ 900 MMcf.
- The model estimates for Case 2 that the total gas production rate will drop below 10 MMcf/d, by mid-year 2024

# After Sept 30, 2021: Prediction Cases 2017



- For the low helium demand case (Case 3), where private industry only requires helium at the rate of 1.320 MM/d (Oct 2017 – Sep 2021) with a total helium production of 2.013 BCF by Sep 2021, the model estimates that there will be 2.595 BCF of undelivered purchased helium gas on Sep 30, 2021.
- For this case, the model estimates that the total gas production rate will drop below 10 MMcf/d, by 4<sup>th</sup> quarter 2025 (calendar year)

# After Sept 30, 2021: Prediction Cases 2017



## Forecasted helium production, 2021 - 2029

| 2017 Prediction Case Results      |         |              |               |
|-----------------------------------|---------|--------------|---------------|
| Cumulative Production - 95%       |         |              |               |
| Helium Produced Since Oct 1, 2021 |         |              |               |
|                                   | 0       | 0            | 0             |
|                                   | Current | CC 10/2017   | Low Rate      |
| (1st of mth)                      | (Bcf)   | (Bcf)        | (Bcf)         |
| Oct-2022                          | 0.374   | 0.530        | 0.874         |
| Oct-2023                          | 0.683   | 0.972        | 1.553         |
| Oct-2024                          | 0.939   | 1.347        | 2.100         |
| Oct-2025                          | 1.151   | 1.665        | 2.549         |
| Oct-2026                          | 1.329   | 1.938        | 2.924         |
| Oct-2027                          | 1.479   | 2.173        | 3.241         |
| Oct-2028                          | 1.606   | 2.377        | 3.512         |
| Oct-2029                          | 1.713   | 2.554        | 3.743         |
| <i>Difference between cases</i>   |         | <b>0.841</b> | <b>1.189</b>  |
| Jul 2017 -<br>Sep 2021            | 2.702   | 3.595        | 2.013         |
| Oct 2021 -<br>Sep 2029            | 1.713   | 2.554        | 3.743         |
| Total                             |         |              |               |
| Jul 2017 -<br>Sep 2029            | 4.415   | 6.149        | 5.756         |
| <i>Difference between cases</i>   |         | <b>1.734</b> | <b>-0.393</b> |

| 2017 Prediction Case Results      |         |            |          |
|-----------------------------------|---------|------------|----------|
| Annual Production - 95%           |         |            |          |
| Helium Produced Since Oct 1, 2021 |         |            |          |
|                                   | 0       | 0          | 0        |
|                                   | Current | CC 10/2017 | Low Rate |
| (1st of mth)                      | (Bcf)   | (Bcf)      | (Bcf)    |
| Oct-2022                          | 0.374   | 0.530      | 0.874    |
| Oct-2023                          | 0.309   | 0.443      | 0.679    |
| Oct-2024                          | 0.256   | 0.375      | 0.548    |
| Oct-2025                          | 0.212   | 0.318      | 0.449    |
| Oct-2026                          | 0.178   | 0.273      | 0.375    |
| Oct-2027                          | 0.150   | 0.235      | 0.317    |
| Oct-2028                          | 0.127   | 0.204      | 0.271    |
| Oct-2029                          | 0.107   | 0.177      | 0.231    |

# After Sept 30, 2021: Prediction Cases 2017



## ■ Forecasted total gas production, 2021 - 2029

| Cumulative Production - 95%          |               |               |               |
|--------------------------------------|---------------|---------------|---------------|
| Total Gas Produced Since Oct 1, 2021 |               |               |               |
|                                      | Case 1        | Case 2        | Case 3        |
|                                      | Current       | CC 10/2017    | Low Rate      |
| (1st of mth)                         | (Bcf)         | (Bcf)         | (Bcf)         |
| Oct-2022                             | 2.838         | 4.516         | 5.781         |
| Oct-2023                             | 5.257         | 8.457         | 10.692        |
| Oct-2024                             | 7.306         | 11.917        | 14.941        |
| Oct-2025                             | 9.042         | 14.943        | 18.628        |
| Oct-2026                             | 10.517        | 17.605        | 21.846        |
| Oct-2027                             | 11.777        | 19.951        | 24.668        |
| Oct-2028                             | 12.857        | 22.011        | 27.154        |
| Oct-2029                             | 13.766        | 23.834        | 29.325        |
| <i>Difference between cases</i>      |               | 10.069        | 5.491         |
| Jul 2017 - Sep 2021                  | 18.229        | 25.529        | 17.492        |
| Oct 2021 - Sep 2029                  | 13.766        | 23.834        | 29.325        |
| <b>Total Jul 2017 - Sep 2029</b>     | <b>31.995</b> | <b>49.363</b> | <b>46.817</b> |
| <i>Difference between cases</i>      |               | 17.368        | -2.546        |

| Annual Production - 95%              |         |            |          |
|--------------------------------------|---------|------------|----------|
| Total Gas Produced Since Oct 1, 2021 |         |            |          |
|                                      | Case 1  | Case 2     | Case 3   |
|                                      | Current | CC 10/2017 | Low Rate |
| (1st of mth)                         | (Bcf)   | (Bcf)      | (Bcf)    |
| Oct-2022                             | 2.838   | 4.516      | 5.781    |
| Oct-2023                             | 2.419   | 3.941      | 4.910    |
| Oct-2024                             | 2.049   | 3.460      | 4.249    |
| Oct-2025                             | 1.736   | 3.026      | 3.687    |
| Oct-2026                             | 1.475   | 2.662      | 3.218    |
| Oct-2027                             | 1.260   | 2.345      | 2.822    |
| Oct-2028                             | 1.080   | 2.060      | 2.486    |
| Oct-2029                             | 0.909   | 1.824      | 2.172    |



# Discussion



Questions, comments, concerns ?

AN INTIMATE PORTRAIT OF THE TOUR DE FRANCE



AN INTIMATE PORTRAIT OF THE TOUR DE FRANCE



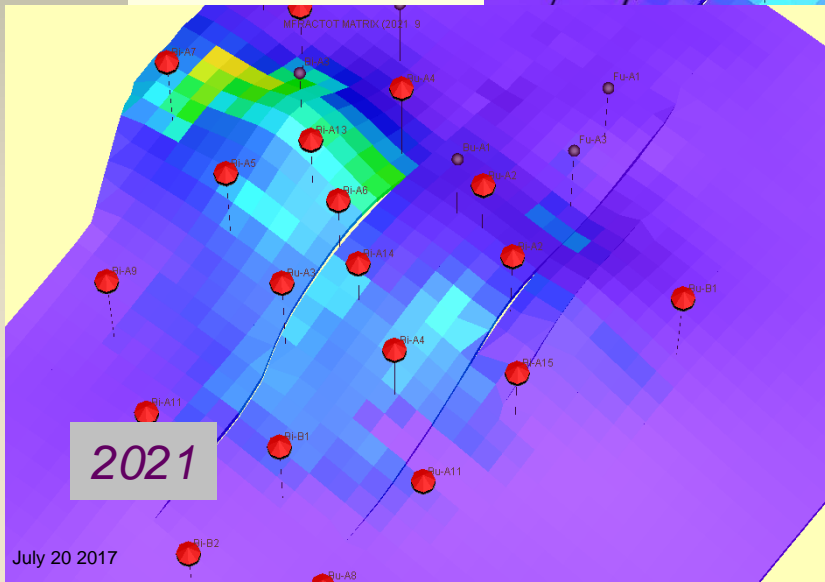
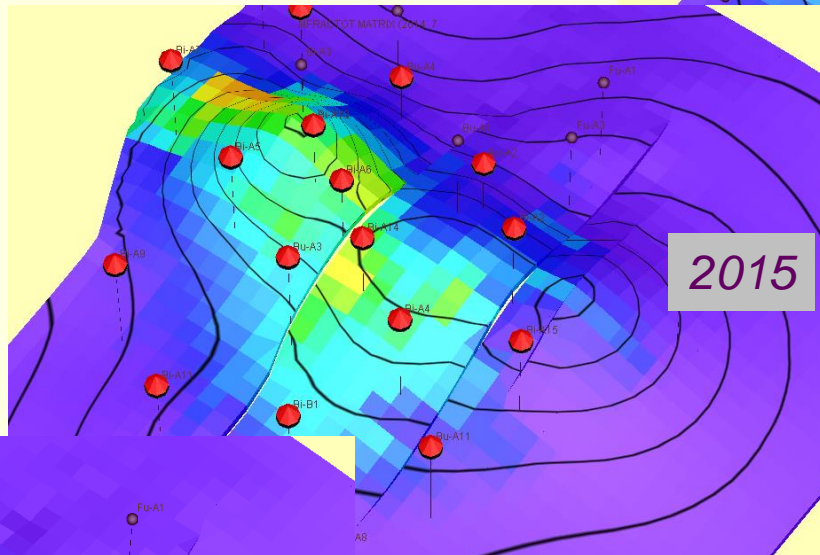
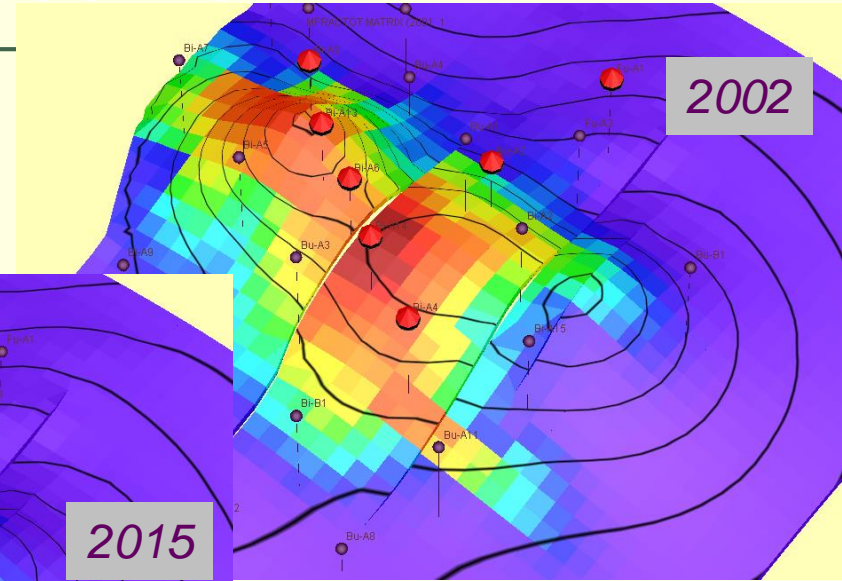
*Celebrating at the end of stage 21, 2016, Tour de France*

*... you always feel smarter after a few beers*  
(Cliff Clavin, Cheers)

# Bushdome Helium Reservoir



*Thank  
You!*



*He Concentration*

