Artificial Lift R&D Council

Plunger lift Observations Liquid loading in the Hz well

Clint Mason Kaizen Well Solutions

ALRDC Artificial Lift Workshop

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Introduction

- **Clint Mason**
- President of Kaizen Well Solutions Ltd. – Well optimization
- Managing partner in Trido Industries, Trido Solutions LLC (solar drive platform development) and Appsmiths LLC (Well Tracer Co2 technologies)
- Started working Oil and gas in 1987, Pipeline & plant construction, well/plant operation, wireline, downhole production tools, optimization

Introduction

- Spent most of my working life focused on well Optimization technologies.
- Plunger lift, Gas lift and Jet pump are some of my key focus areas over the past 30 plus years
- Multiple patents
- Been part of many plunger lift equipment design developments that are standard today
- Was part of the API 11 PL committee on lubricators design requirements

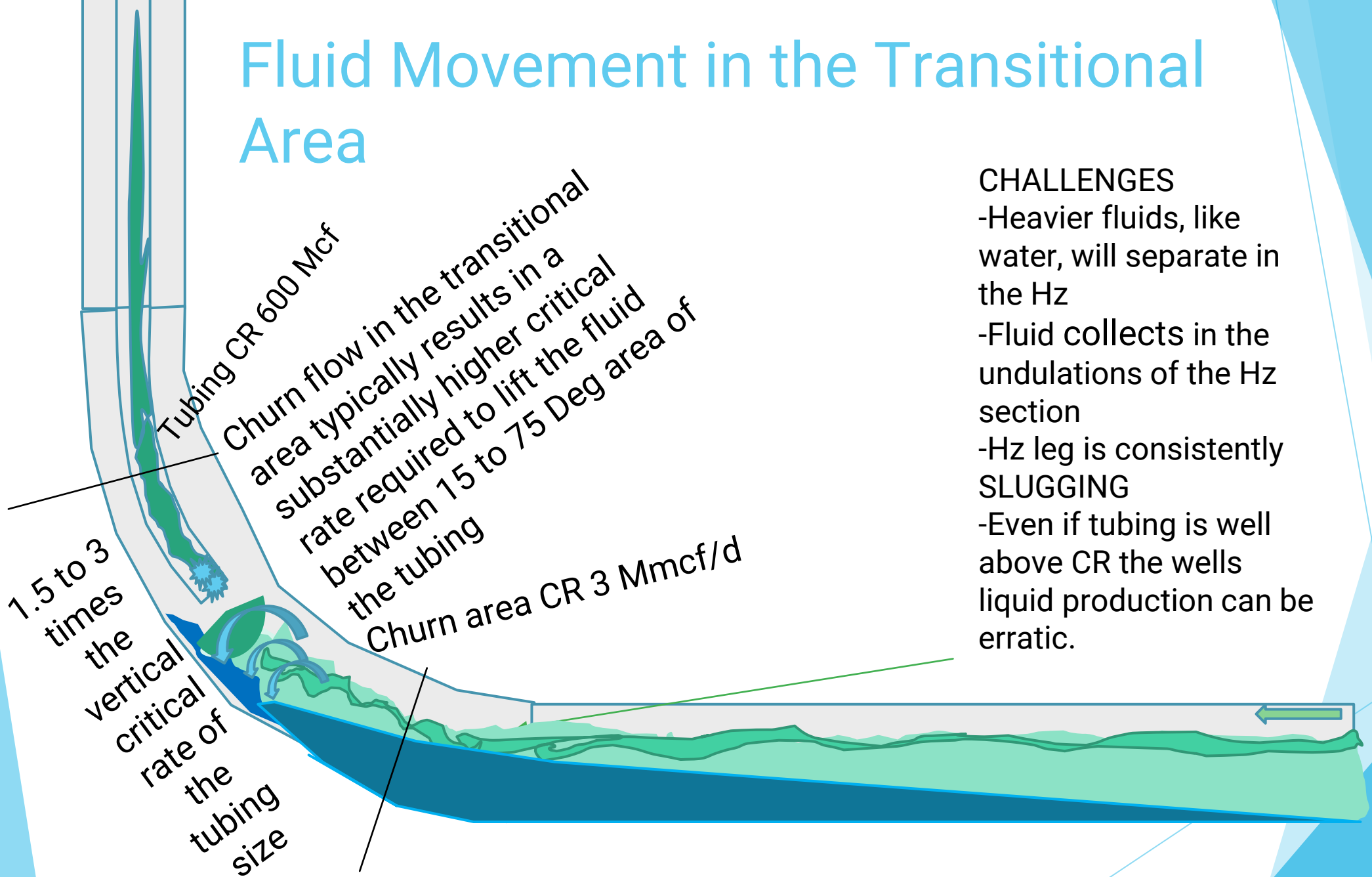
Let's talk about our thought process when we approach liquid loading

Typically, “Tubing focused” and based on our known Vertical well experience

- When
- Where
- What
- Why

But is focusing on the EOT to surface optimal for optimization? Where are the potential fluid hang up areas? When is fluid hang up happening? Why is this happening?

Fluid Movement in the Transitional Area



CHALLENGES

-Heavier fluids, like water, will separate in the Hz

-Fluid collects in the undulations of the Hz section

-Hz leg is consistently SLUGGING

-Even if tubing is well above CR the wells liquid production can be erratic.

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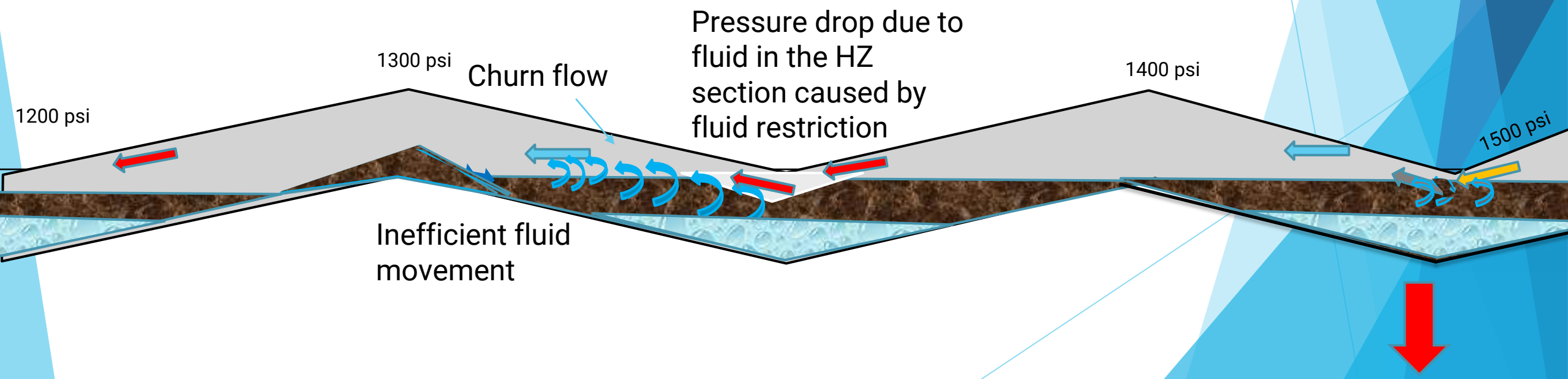
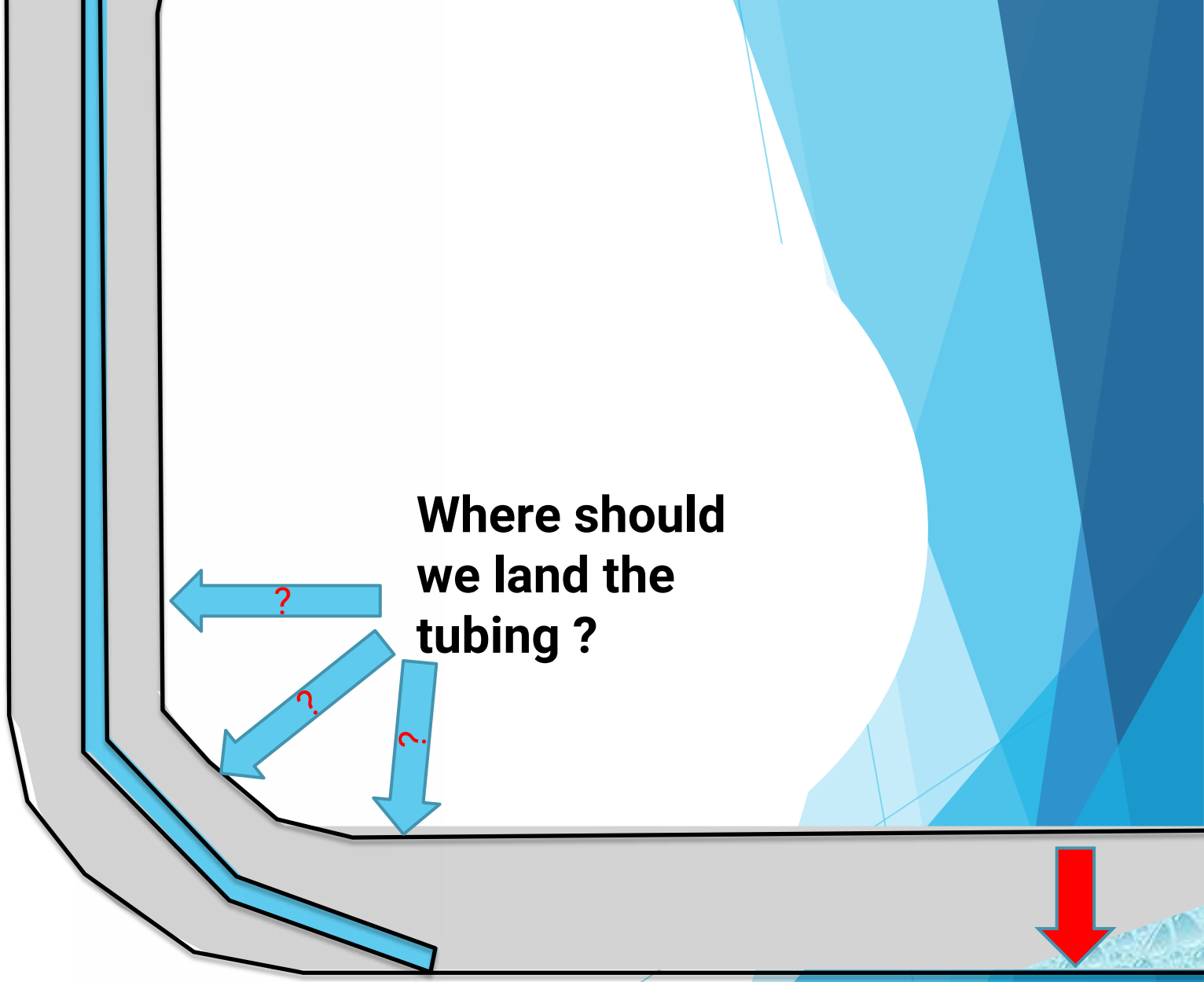
Is there enough flow to effectively move fluid from the low points and heavier fluid ?

The Hz section is never a nice straight line. There are many oscillations within the HZ potentially adding up to hundreds of points, creating significant flow restrictions and fluid hold up.



End of Tubing Observations Setting yourself up for success

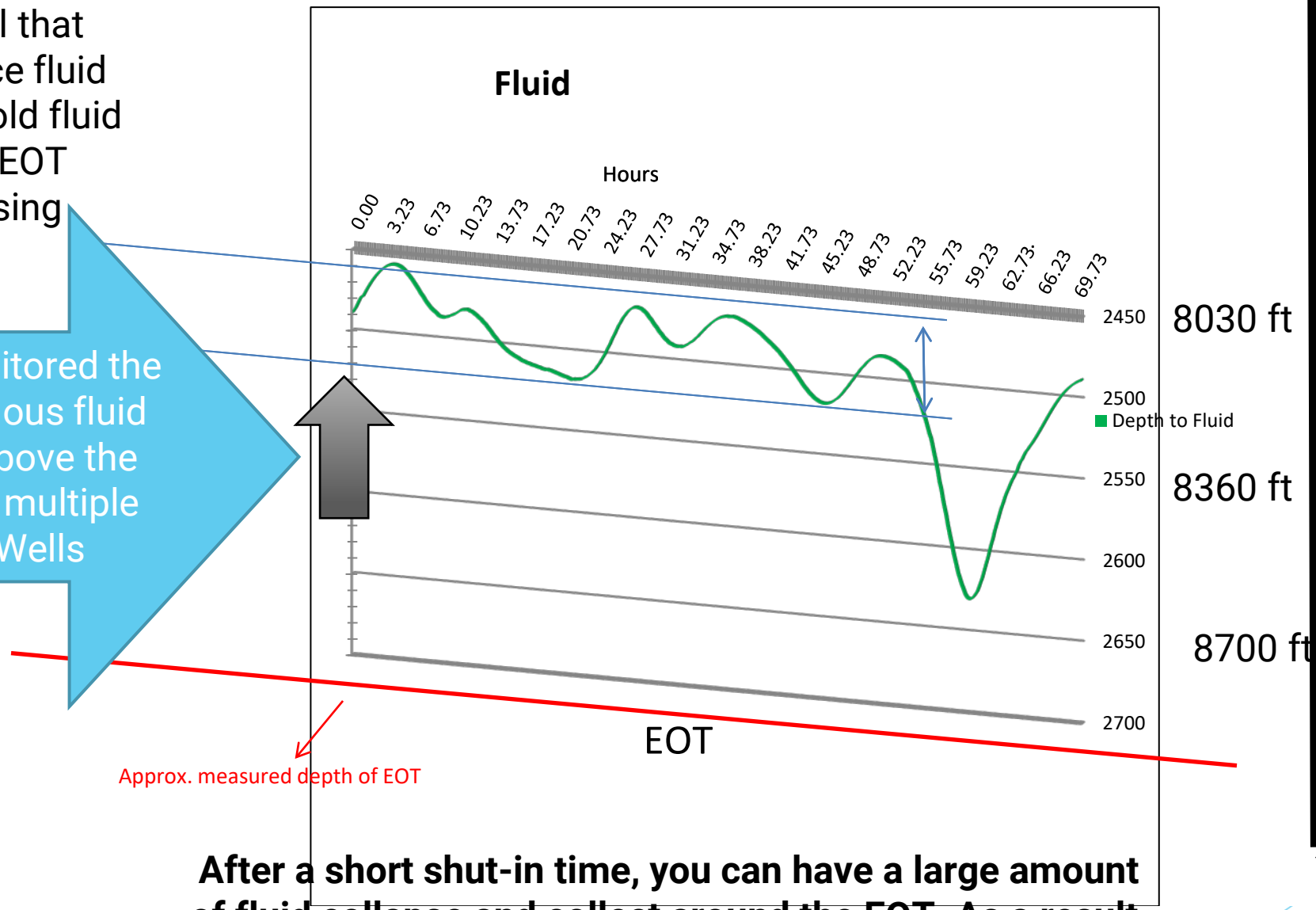


Operating similarities we identified in troublesome wells

- Wells with even a short shut in 5-20 minutes will not restart without - swabbing or blowing out with Nitrogen
- First few swabs were high % water cut even in low % water cut wells
- Well loads up unexpectedly and erratically even with high flow rates
- Excessive DP between tubing and casing pressures
- High percentage had a EOT below 75 deg.
- Most were 80-90 deg. EOT

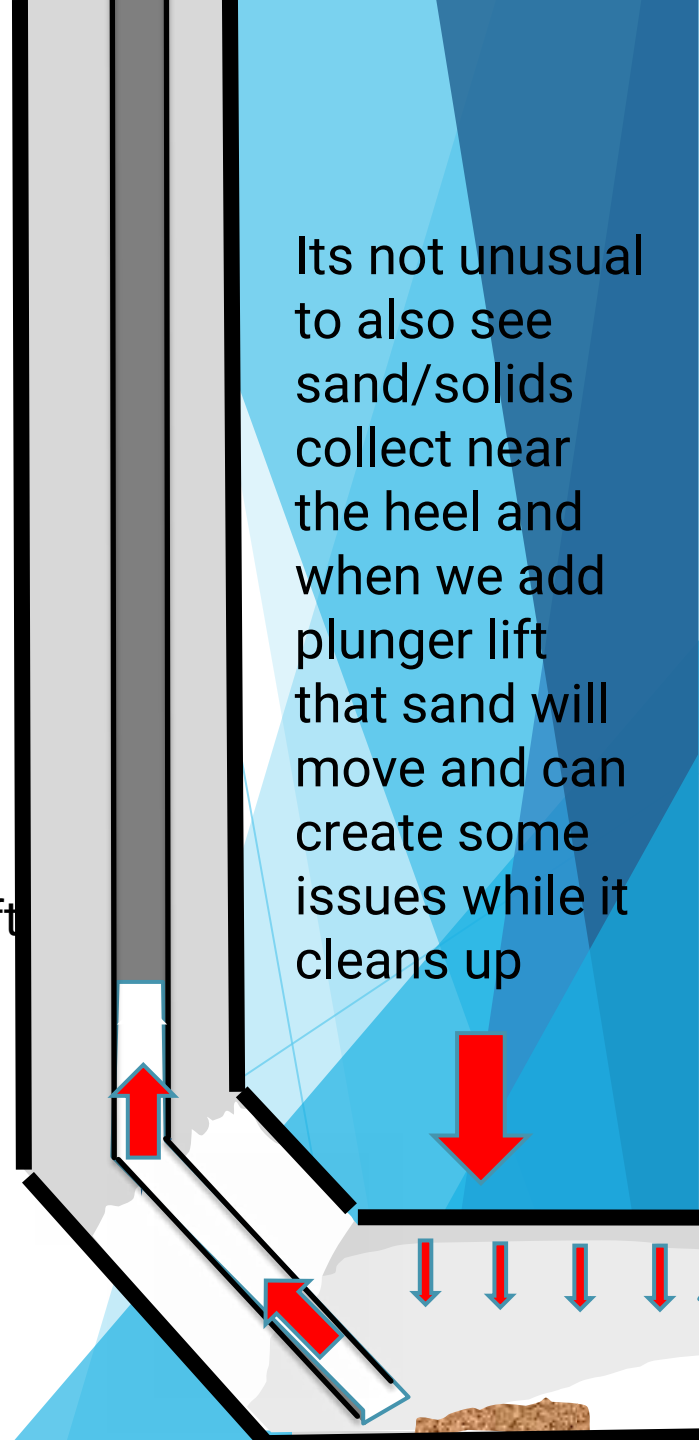
Hz well that produce fluid can hold fluid above EOT (no casing flow)

We monitored the continuous fluid level above the EOT in multiple Hz. Wells



After a short shut-in time, you can have a large amount of fluid collapse and collect around the EOT. As a result, this can make it difficult to restart the well because of the amount of fluid entry into the tubing

Its not unusual to also see sand/solids collect near the heel and when we add plunger lift that sand will move and can create some issues while it cleans up



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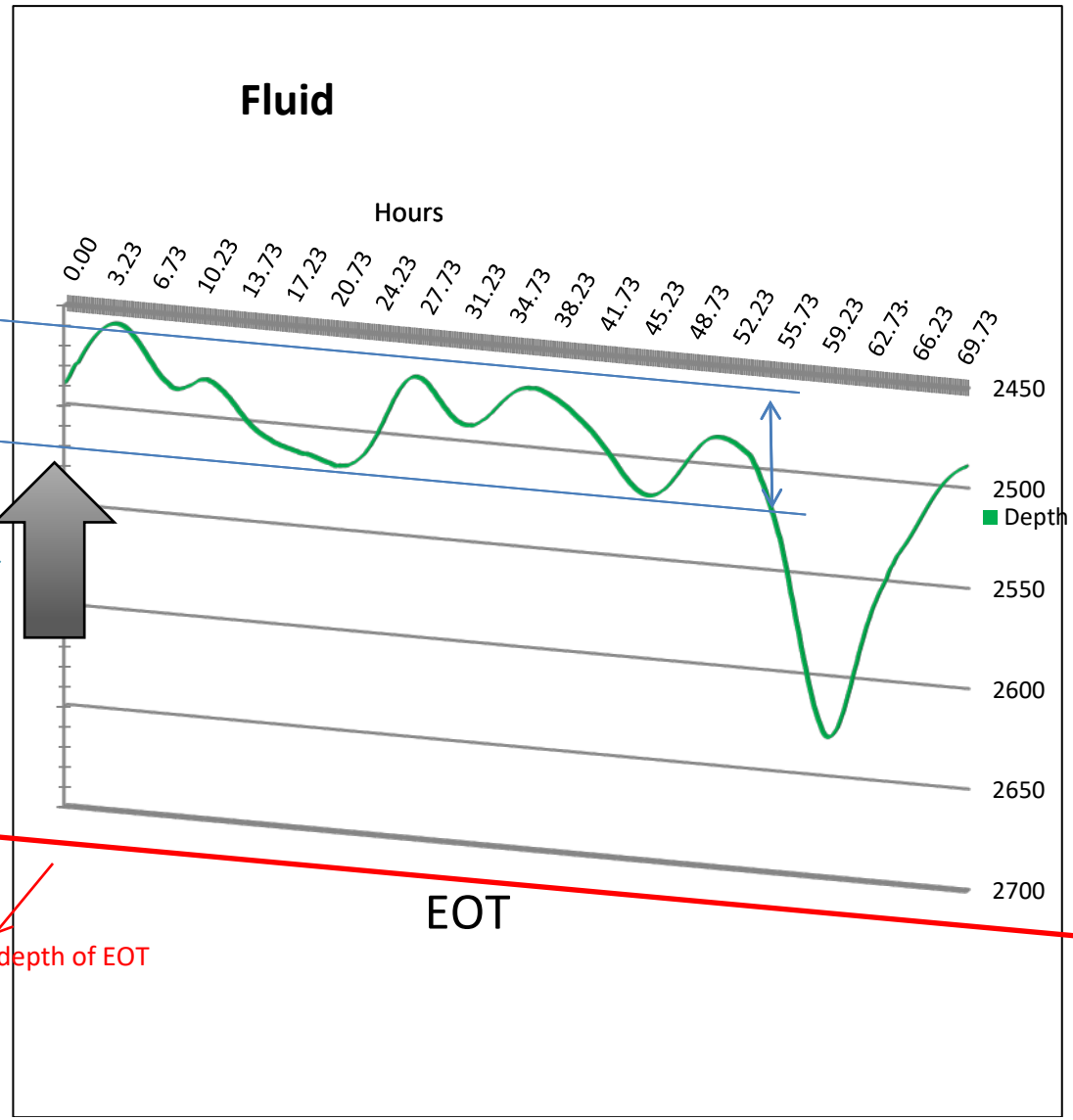


When we have our EOT at 70 deg we find that restarting wells after shut in is more effective and we also know that when we perf tubing at 70 deg wells will flow that would not prior

EOT at 7 deg.

Typical EOT position 70 deg

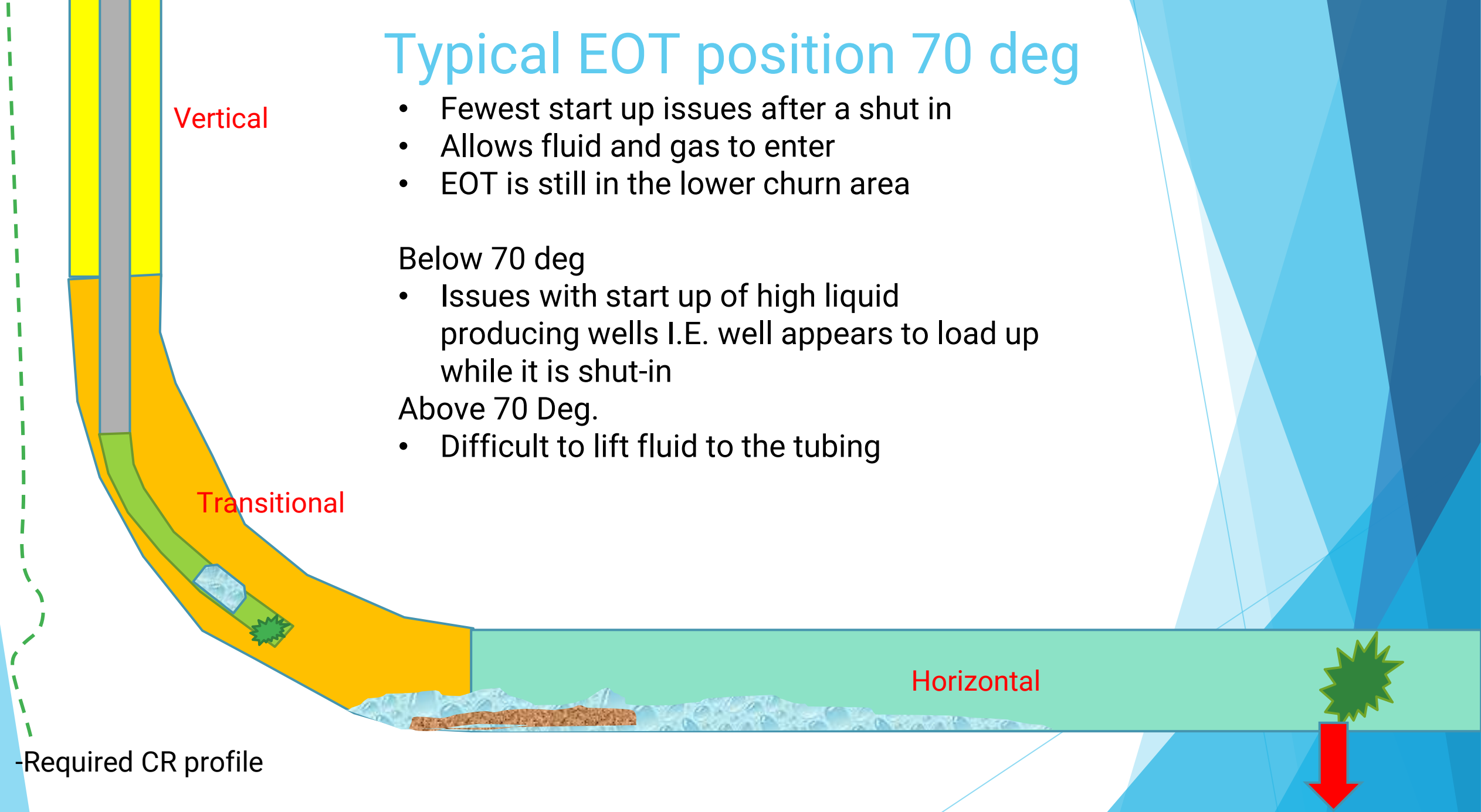
- Fewest start up issues after a shut in
- Allows fluid and gas to enter
- EOT is still in the lower churn area

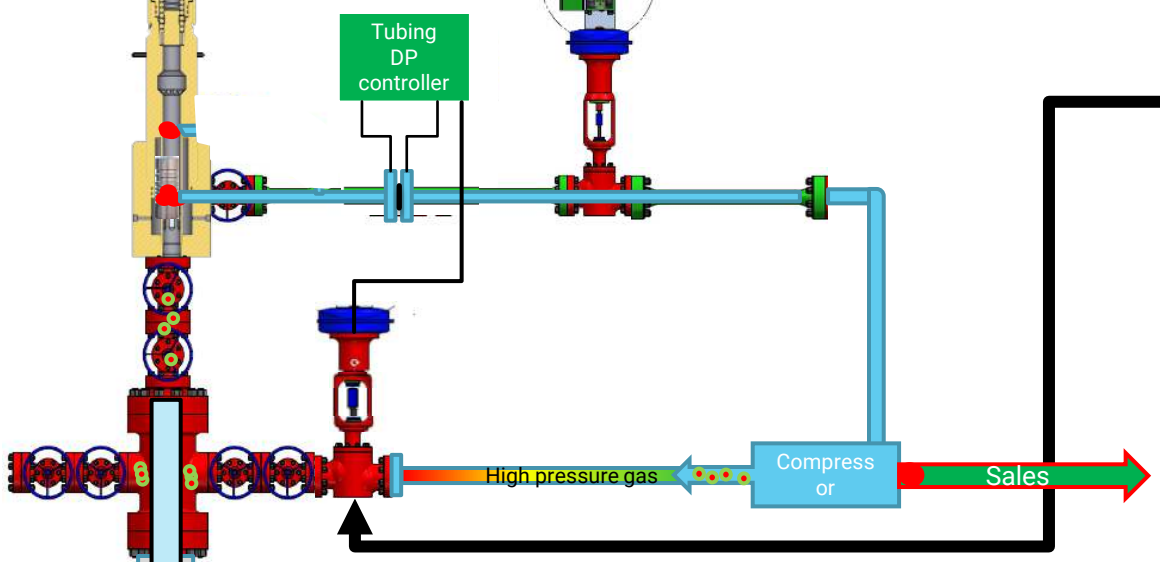
Below 70 deg

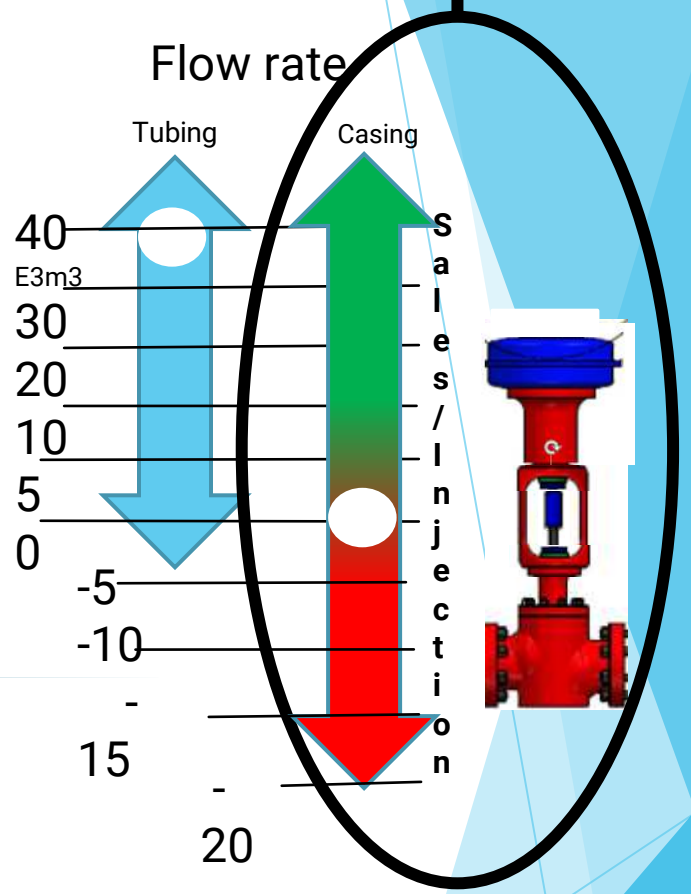
- Issues with start up of high liquid producing wells I.E. well appears to load up while it is shut-in

Above 70 Deg.

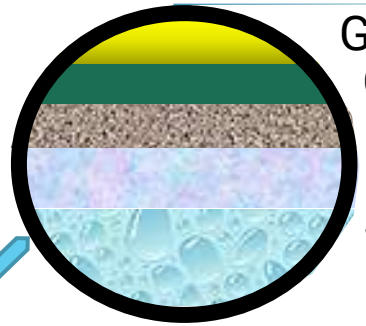
- Difficult to lift fluid to the tubing







Doing a great job of unloading the Tubing



Water Builds up in the Churn area

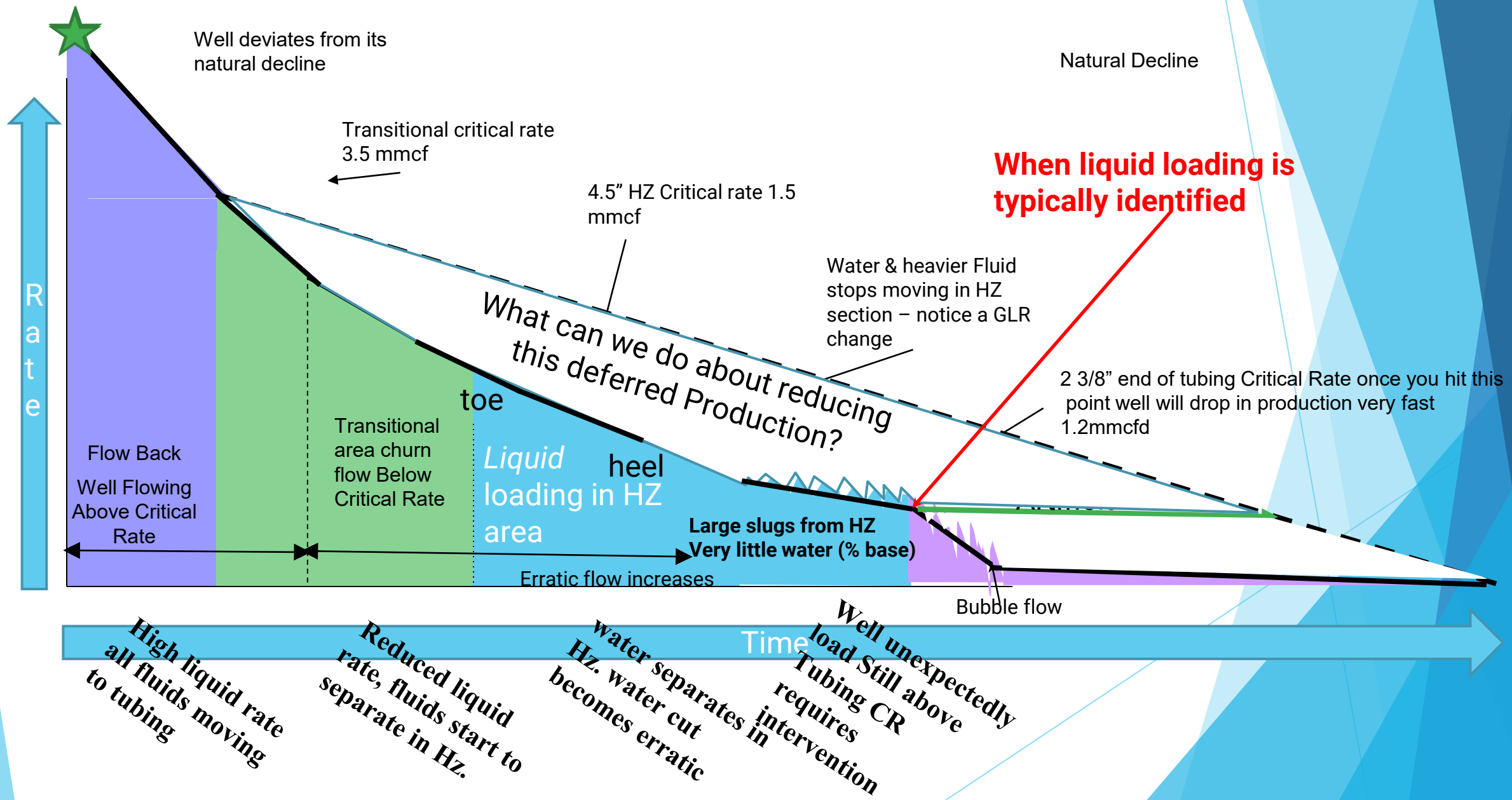
GAPL/PAGL Applications

Liquid fall back in the transitional area

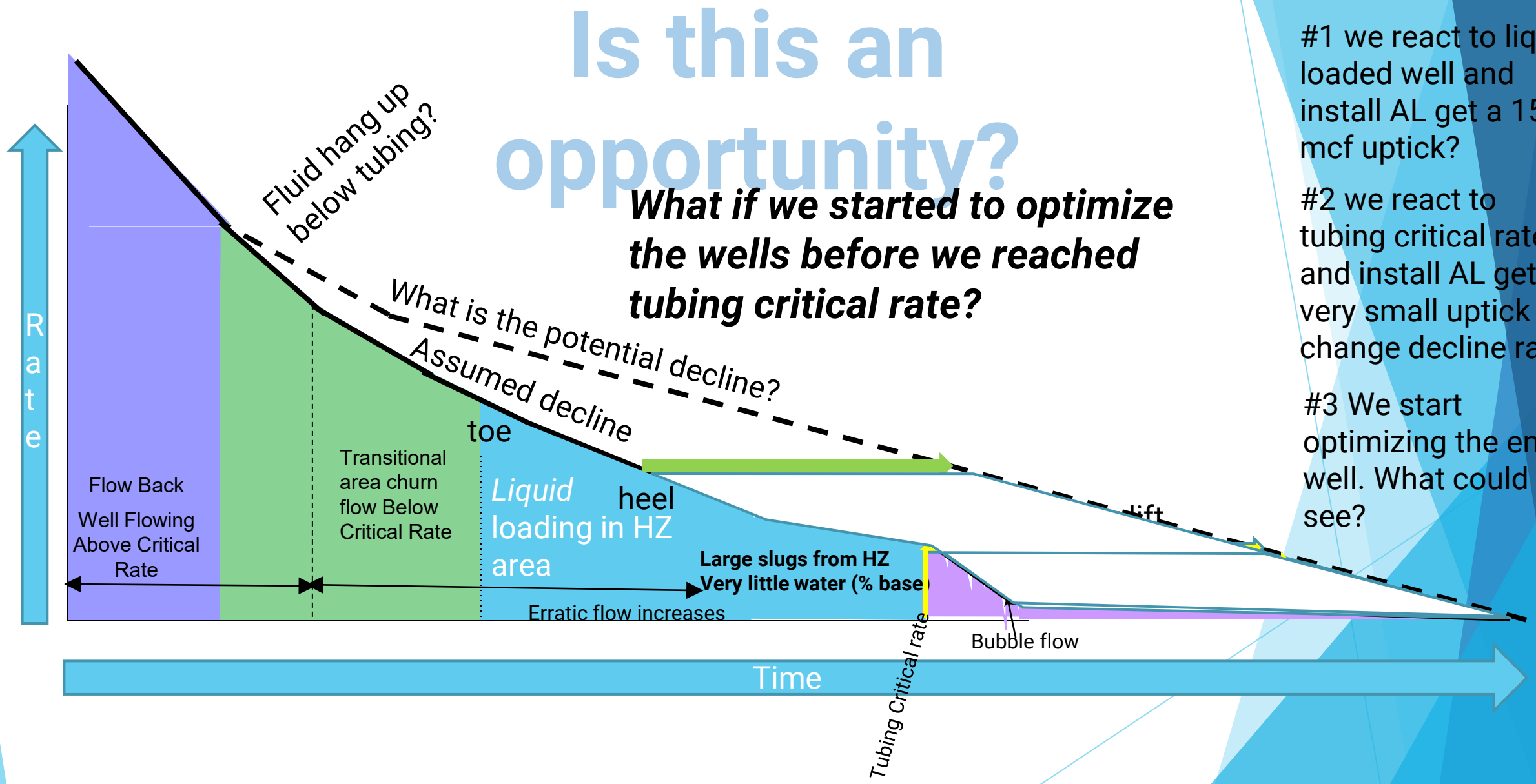
Liquid slugs or slurrs along HZ casing area building up in low spots

If we are missing the Liquid loading below the Tubing Could we be missing potential production too?

Stages of liquid loading HZ – long before tubing loading



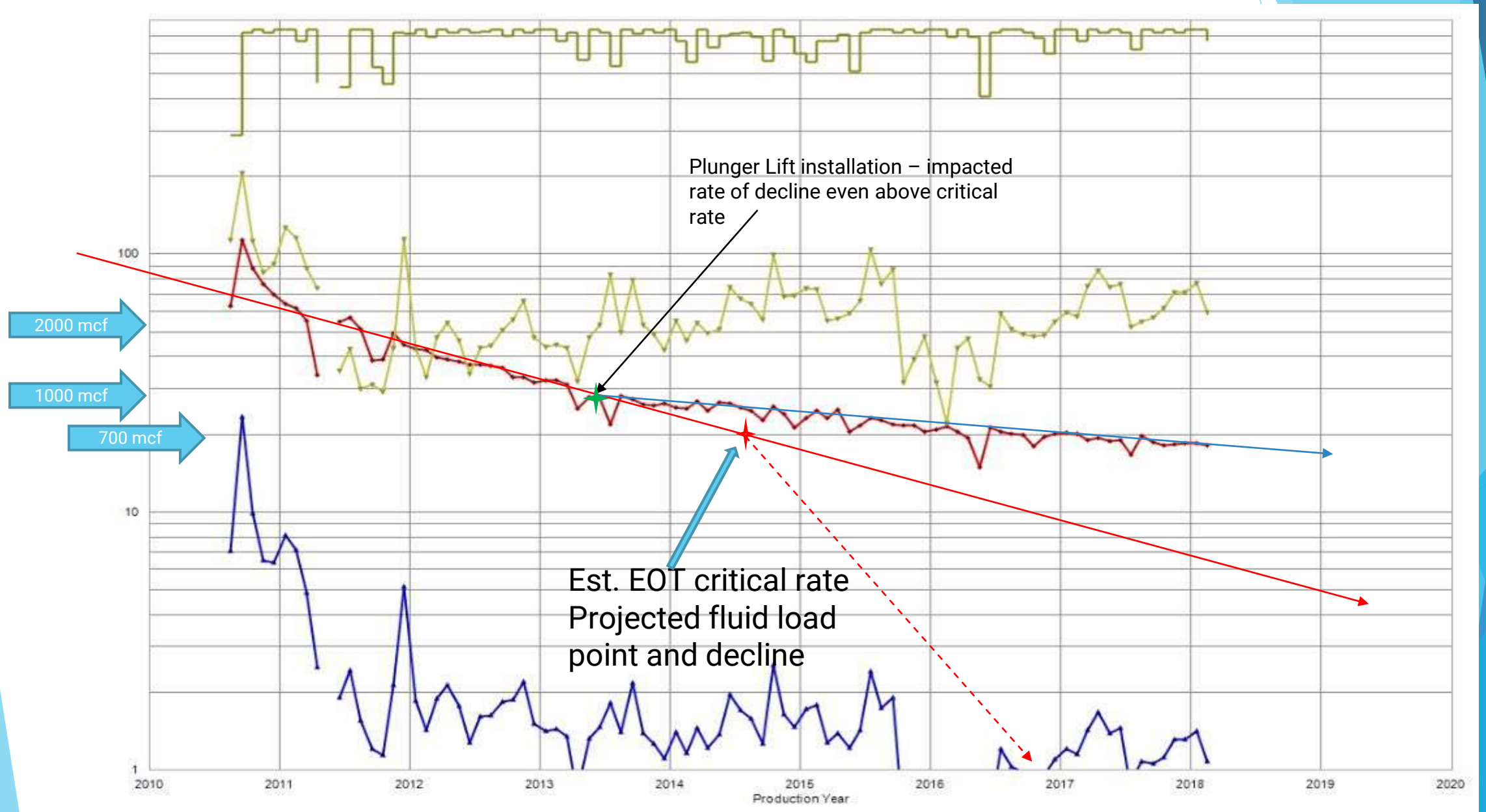
When should we apply artificial lift…

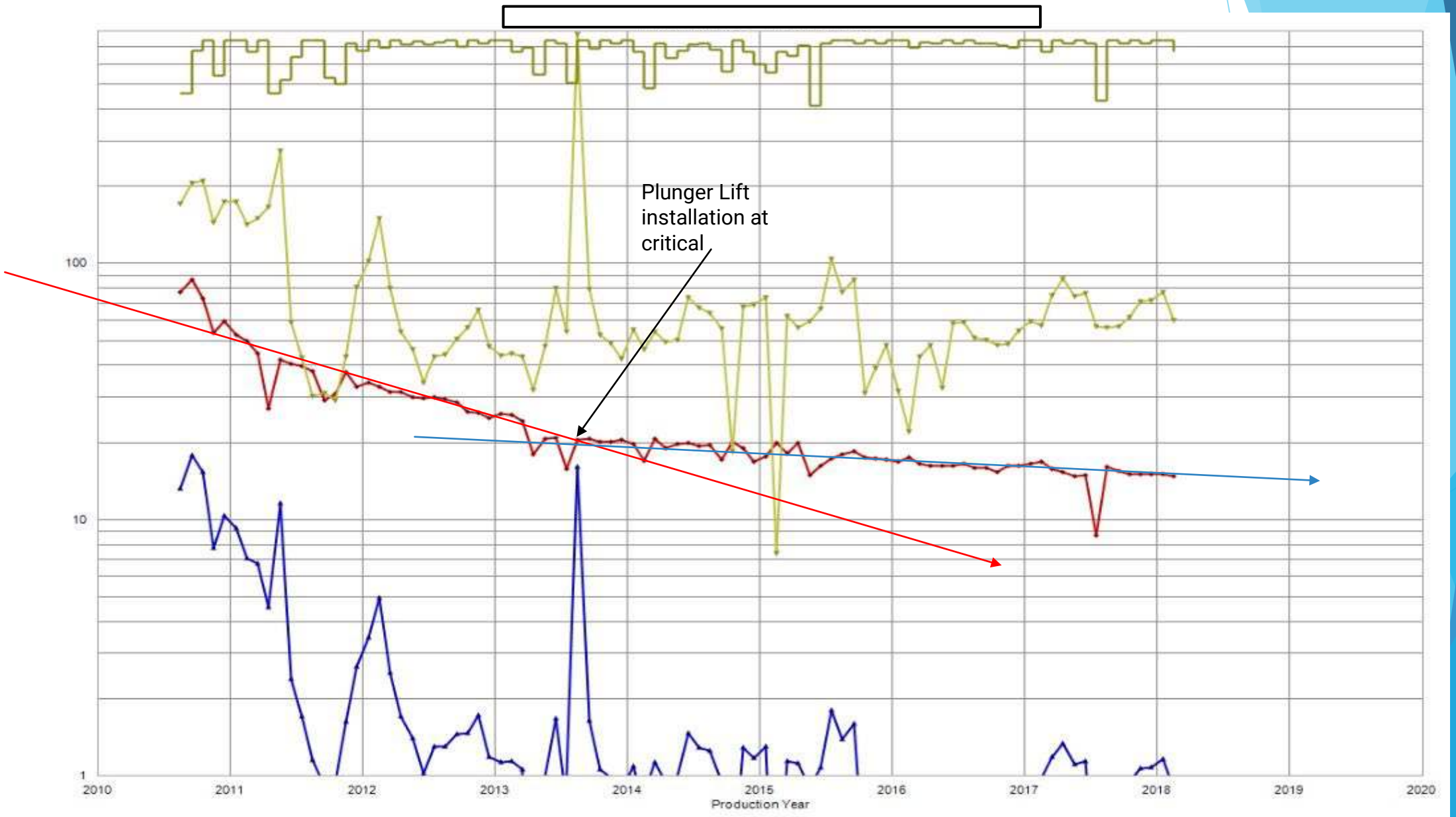


#1 we react to liquid loaded well and install AL get a 150 mcf uptick?

#2 we react to tubing critical rate and install AL get very small uptick but change decline rate

#3 We start optimizing the entire well. What could we see?


Plunger Lift installation – impacted rate of decline even above critical rate
2000 mcf
1000 mcf
700 mcf
Est. EOT critical rate
Projected fluid load point and decline
100
10
1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Production Year


Plunger Lift installation at critical
100
10
1
2010
2011
2012
2013
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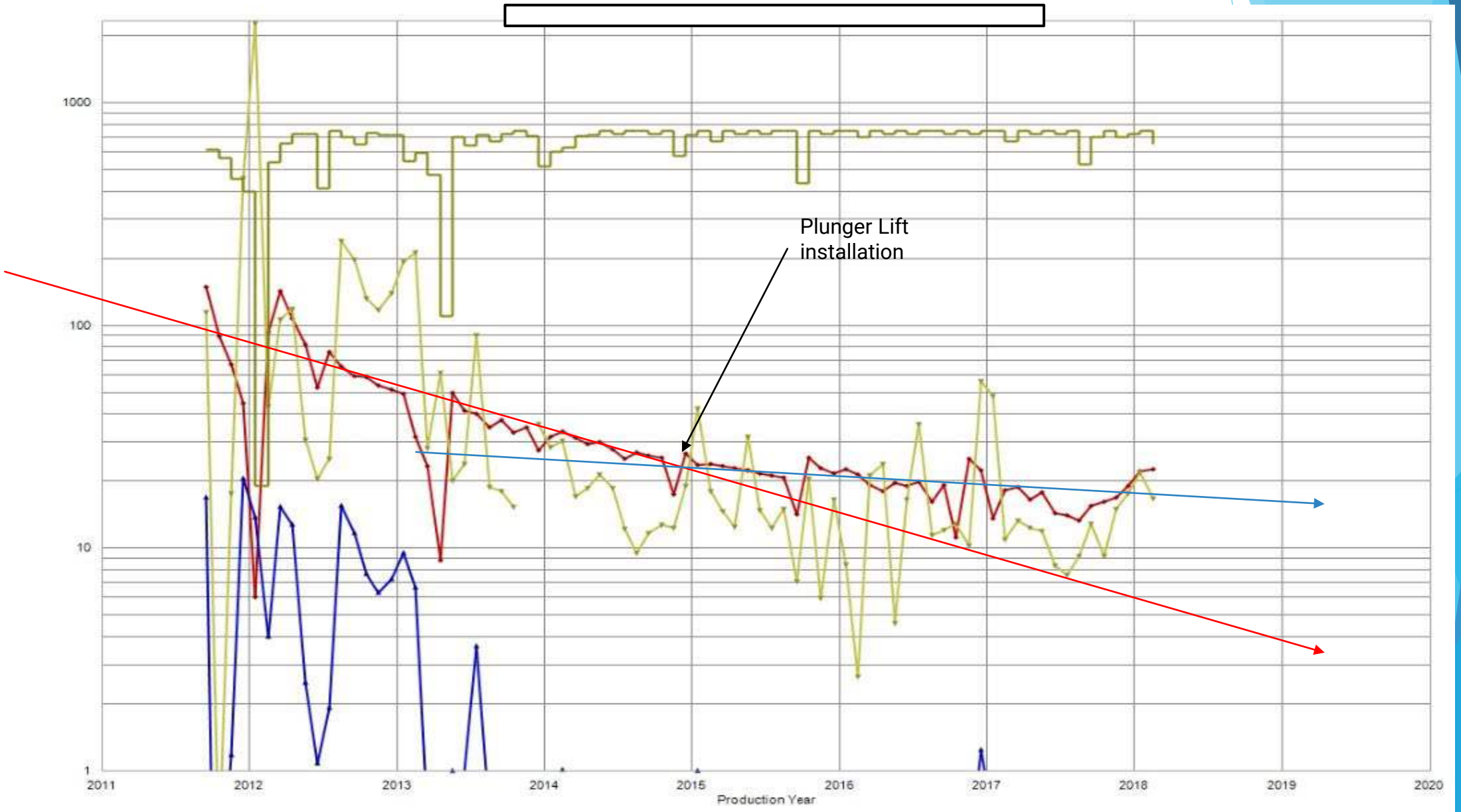
2020
Production Year


1000
100
10
1
2011
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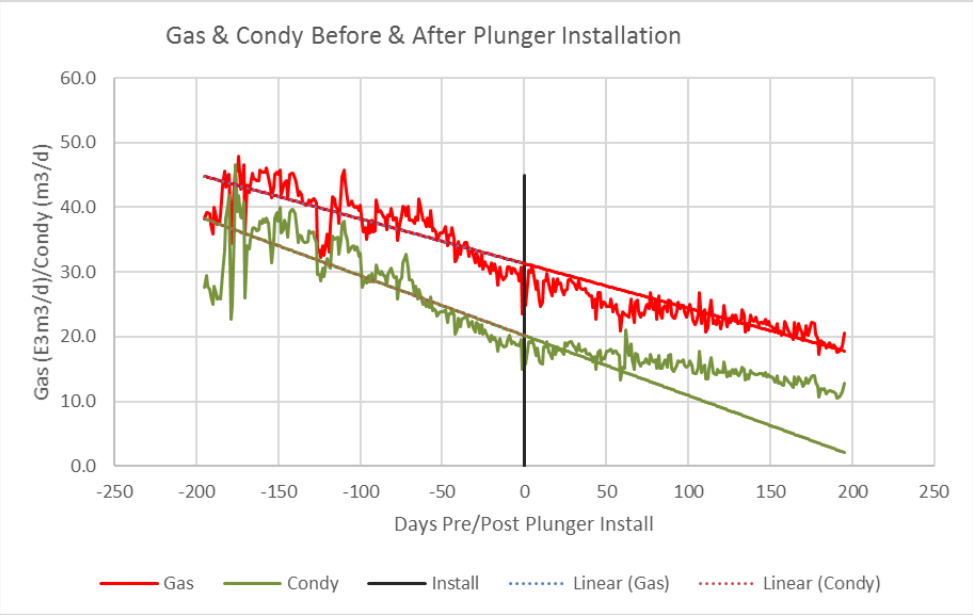
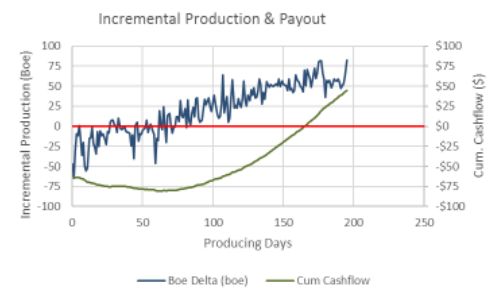
2017
2018
2019
2020
Production Year
Plunger Lift
installation

Pad project 1

Installs after liquid loading

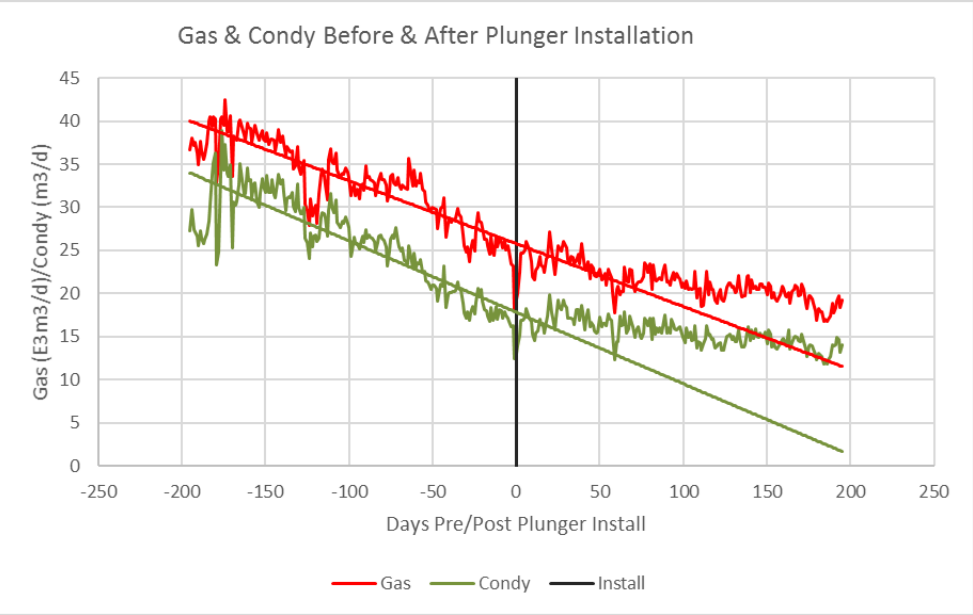


- Older wells show loading prior to install & steady production after

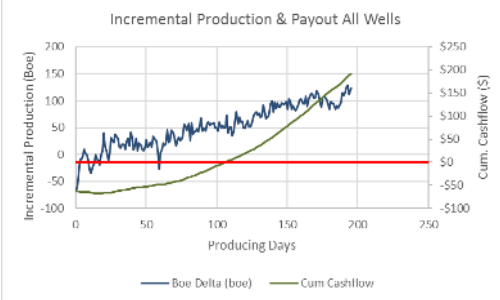


Pad project 2

Installs before liquid loading



- Newer wells show reduced and steady decline with no loading/downtime



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Observations

Observation #1

Long before the wells are typically identified as having issues with liquid loading in the tubing, Liquid loading has been occurring in the transitional and Hz section of the well. Impacting production

Observation #2

There are limited solutions to moving fluid in the Hz area

Observation #3

Early intervention can have significant positive impact on decline rates on even currently strong, free flowing wells. Delayed intervention has a significant negative impact on wells production

Points to consider with an Hz. Well

Solution to maximizing production

Optimize the entire wellbore, liquid loading is happening before tubing is liquid loading early intervention can have significant positive impact.

Results

Early implementation results in increased recovery

Use the wells energy to move fluid HZ to the tubing

Key learning

Focus on decline rate, not hours on. More hours per day might not equal more production

Identified Failure points in our current methodology

- Using production increase as the “gauge” of success
  - If you wait for the production to drop low enough to result in production increases, there has been significant lost opportunity
- There are positive effects by implementing early optimization strategies on Hz well to help remove fluid build up in **fluid hang up areas**.
  - It is much harder to succeed implementing optimization methods after the well is loaded than if we employ a proactive early implementation strategy

Conclusion and evaluation Hz wellbore

- We can optimize the tubing using several AR methods very efficiently
  - BUT these AR methods are not likely optimizing the transitional and Hz sections of the well.
- Manipulating the well flow patterns can add benefits in deliquefying the HZ section beyond efficient removal of liquids in the tubing. **Extra closed time might be beneficial**
- EOT position is Key
- The rules of thumb in plunger selection built around Vertical wells does not always apply in Hz wells

Final word on this

With HZ wells, the learning never stops ….

Don’t be hesitant to try something different…

Acknowledgements/Thanks & Questions

- Thanks to my team at Kaizen Well Solutions/Appsmiths and Trido Industries
- Dr. Anand Nagoo for letting me bounce my thoughts and idea off of him around flow patterns in the Hz. and transitional areas of the wellbore
- Thanks to all of our customers that have worked with us to gather data and work together to identify some best practices and the opportunity to expand my understanding of Hz wells.
- Thank you to the ALRDC and its members for hosting this valuable event

Questions?

Please …. Don’t ask me to do the math ☺

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