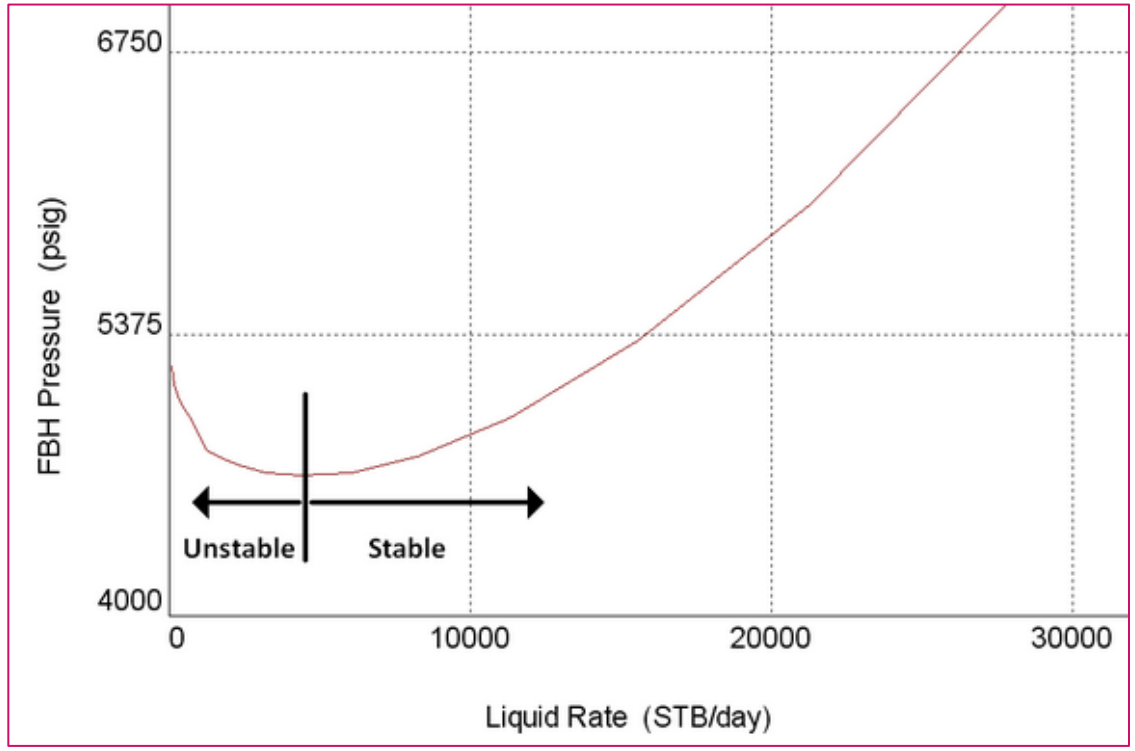
On a route to more stable wells

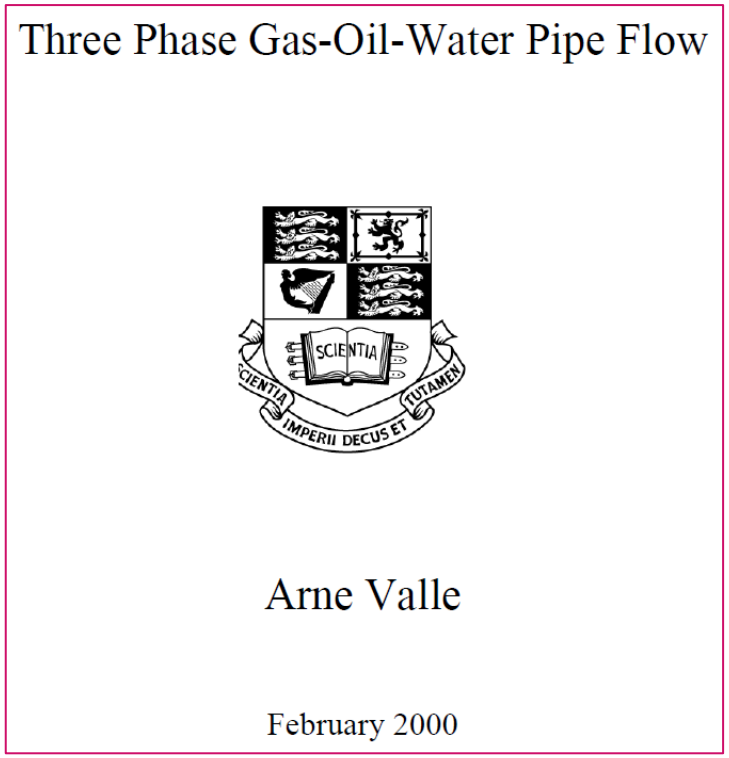
What can be done in the lower completion to reduce slugging?

Background

- **Two phase stability**

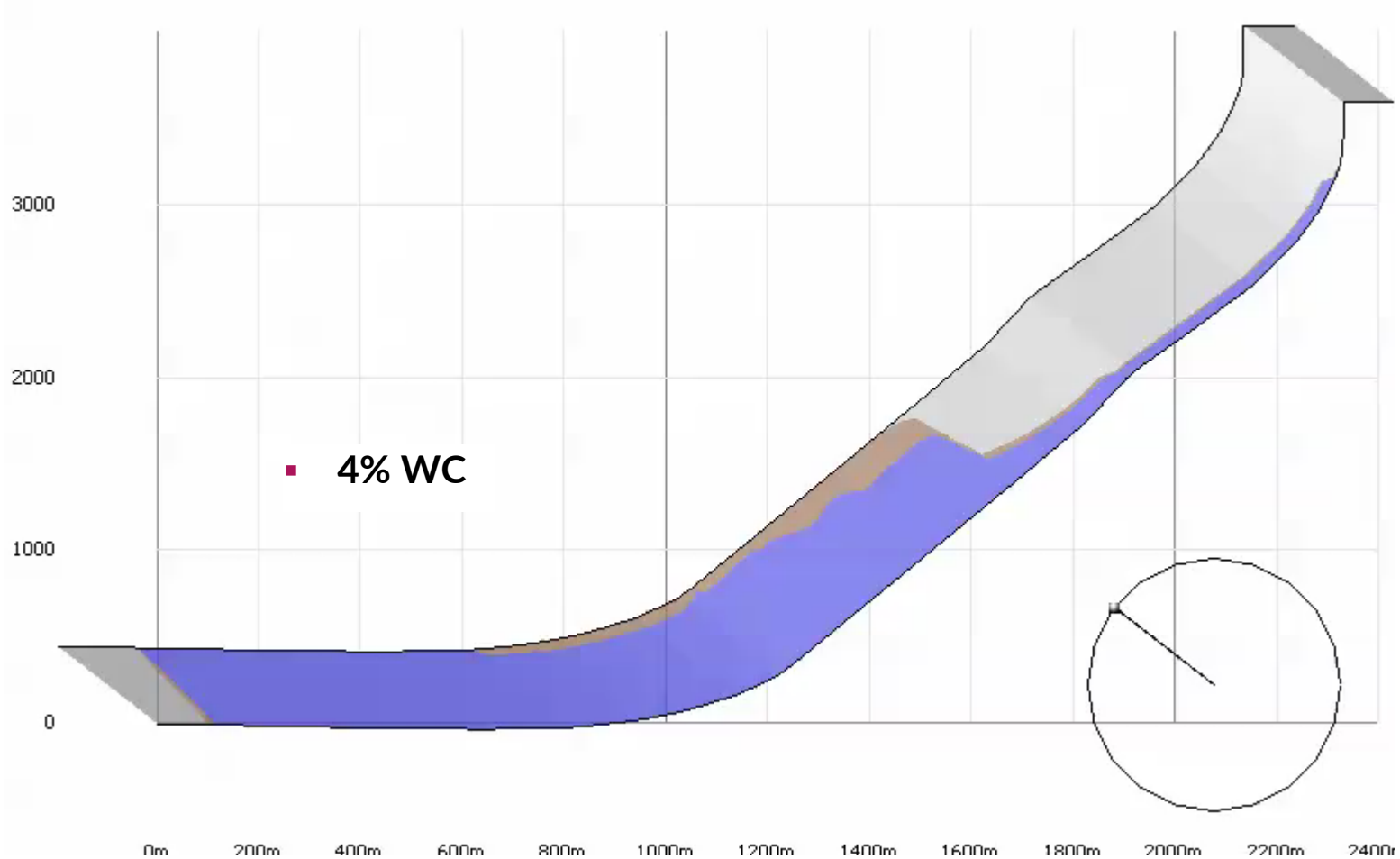


- **Three phase stability**



Tubing approach

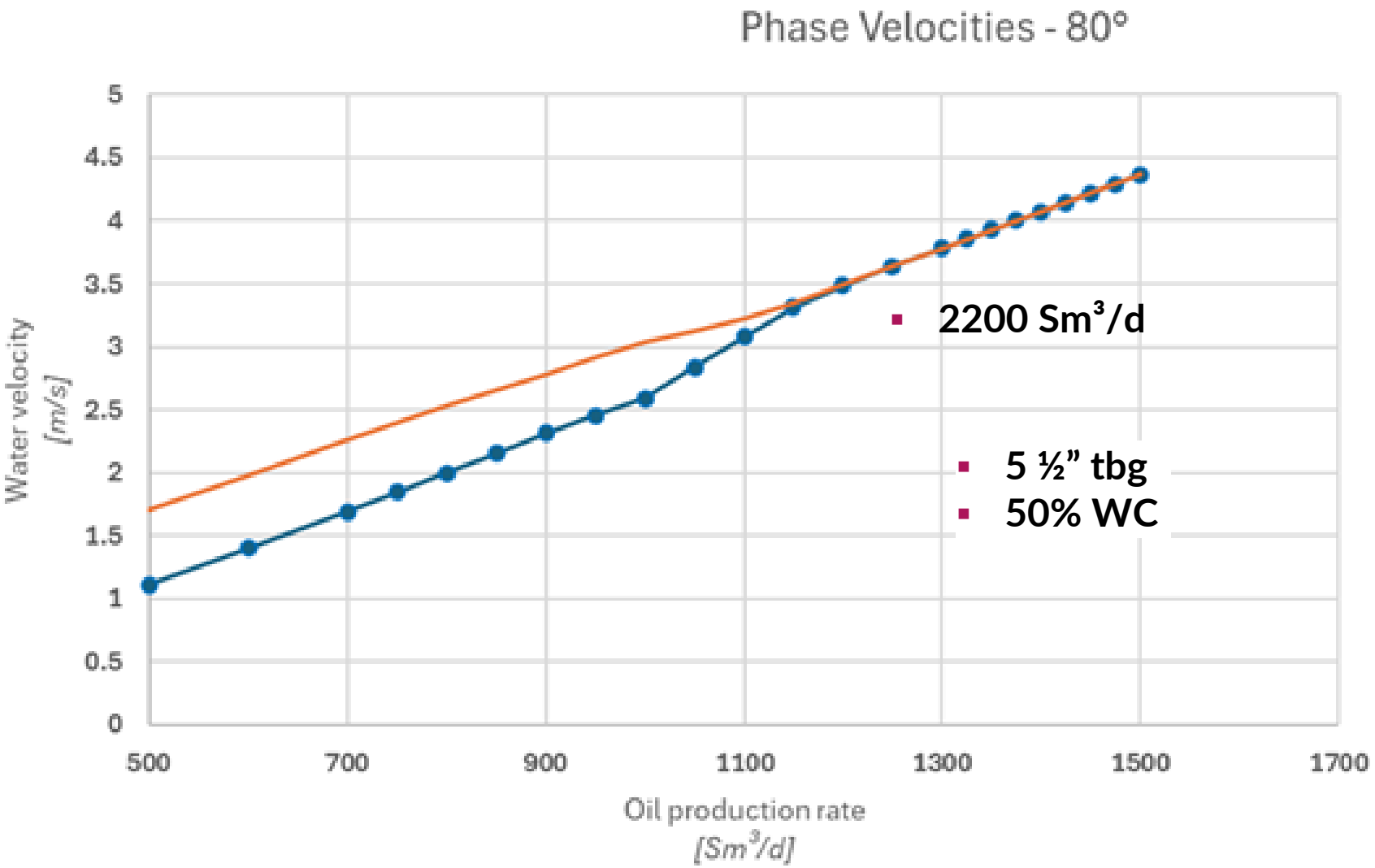
Proof of accumulation



Slugging mechanisms in the tubing

- Slugging caused by segregation and accumulation of water in long sailing sections of the well
  - Such slugging can typically be predicted for liquid rates as high as 1200 – 1500 Sm^3/d (5 ½" tbg)
- Slugging caused by large "water-locks" in a sump in the heel section of the well
  - Such slugging can typically be predicted for liquid rates as high as 1100 – 1200 Sm^3/d (5 ½" tbg / 6 $^5/_8$" SAS)

Modelling of accumulation



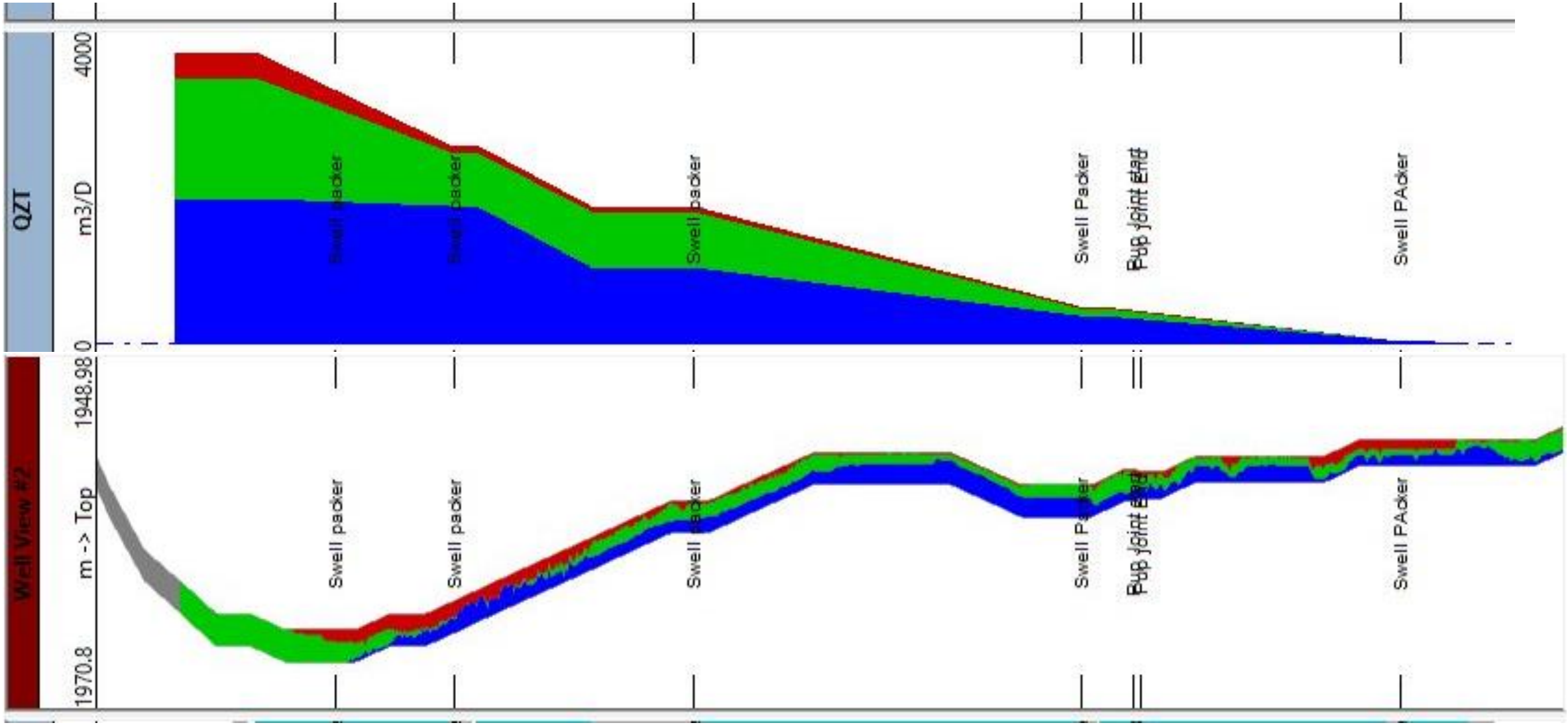
Both OLGA and LEDAFlow is hardcoded to "skip" stratified flow regime for inclinations less than 70-75°

Field observations

What about the lower completion?

Problem: “The tubing is required to take in whatever it receives.”

Typical wellpath and inflow profile



The hydraulic amplifier

Tank instability modelling (2011)

Hydraulic Amplifier!

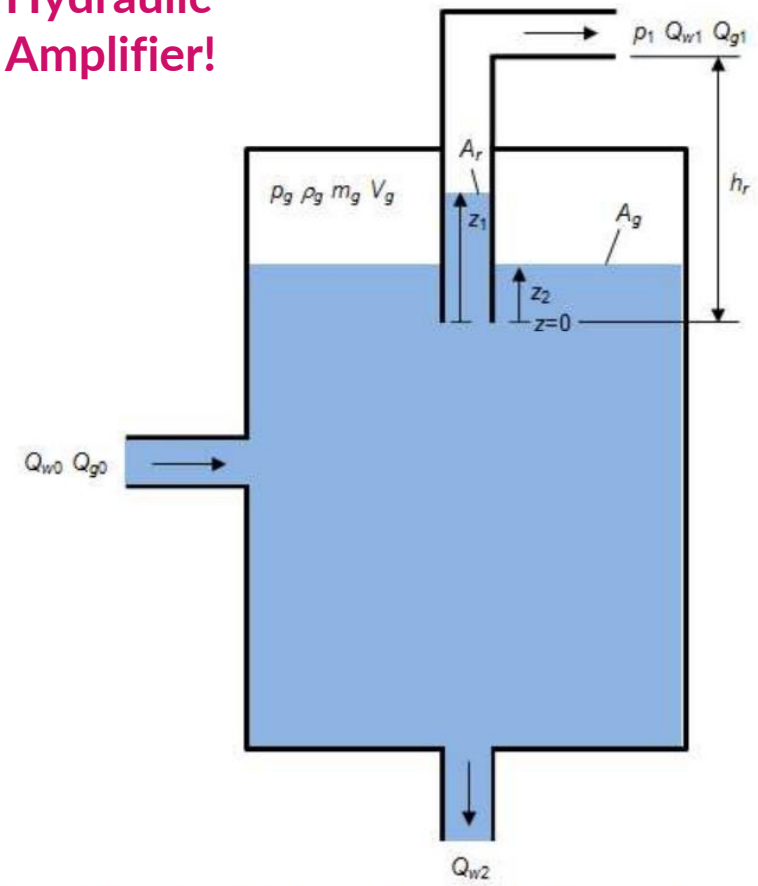
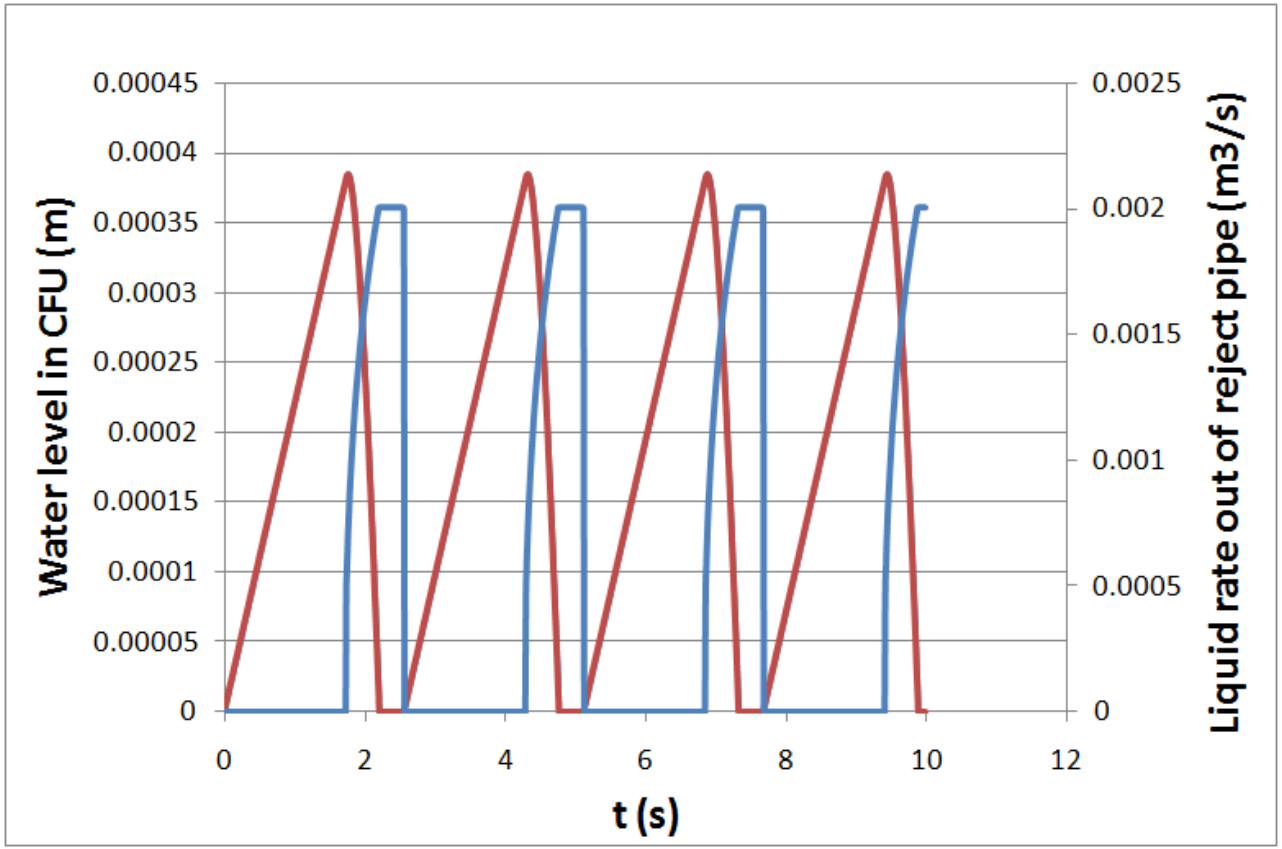
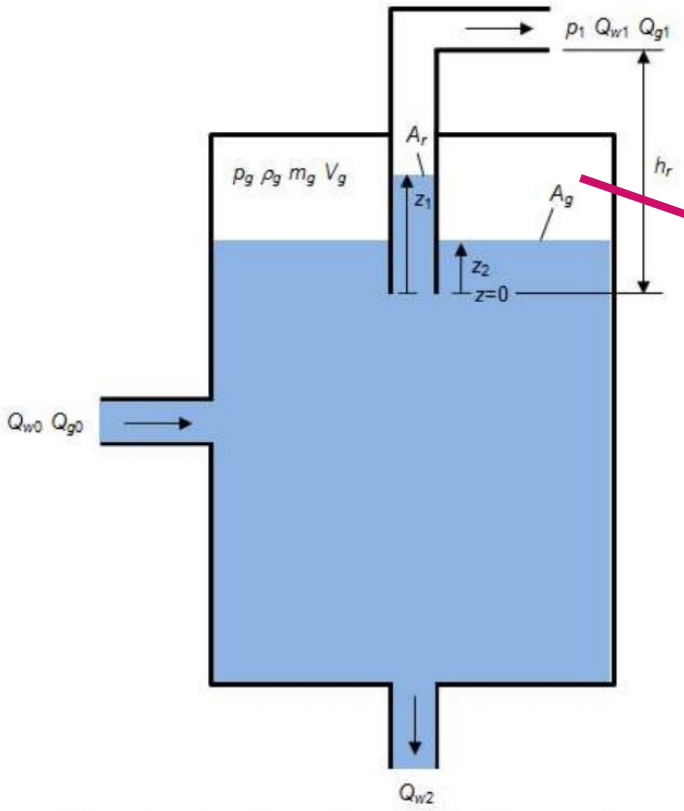


Figure 55 Simplified geometry for reject flow model



Slug amplification in dead volumes

Hydraulic Amplifier!



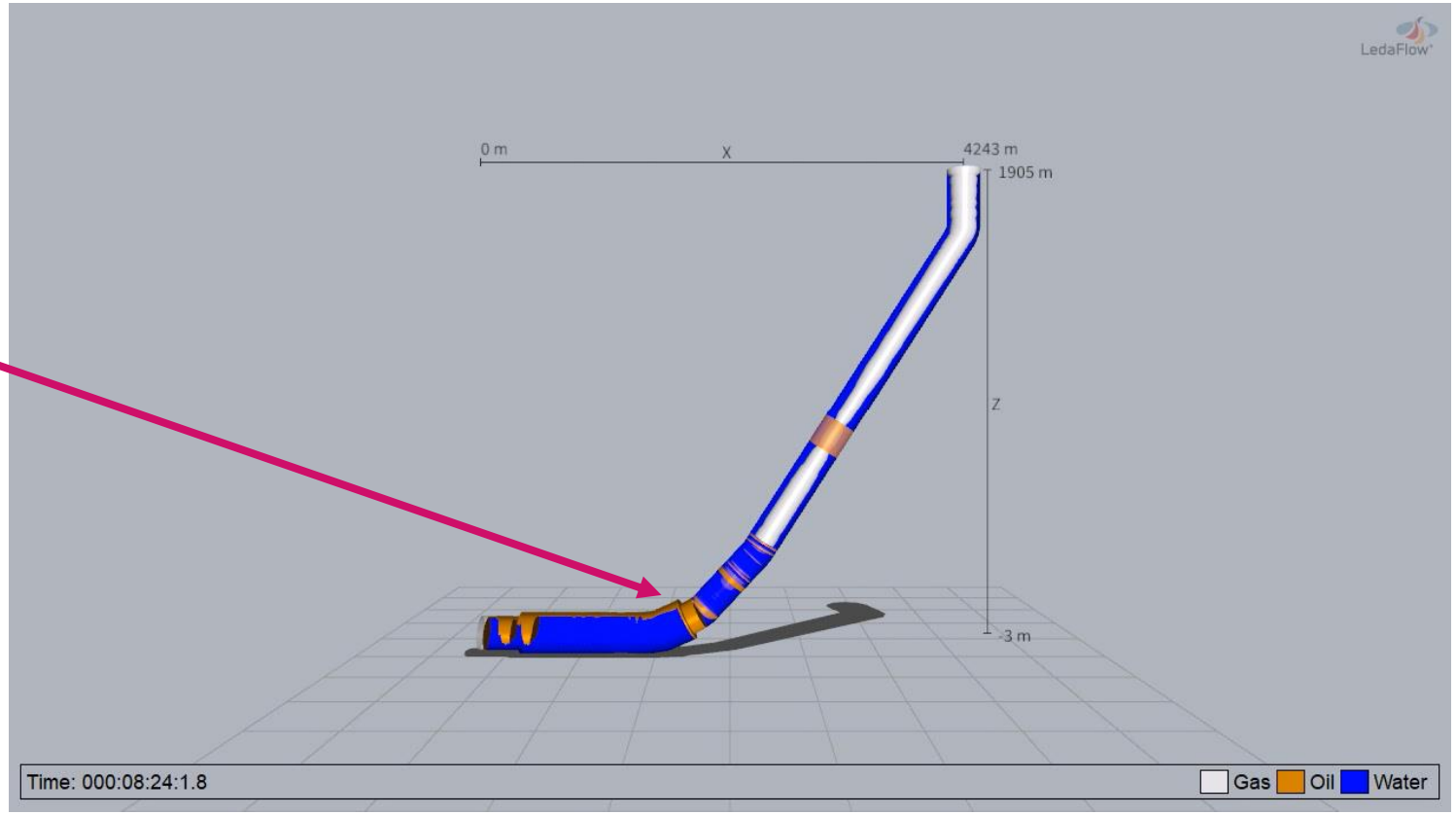
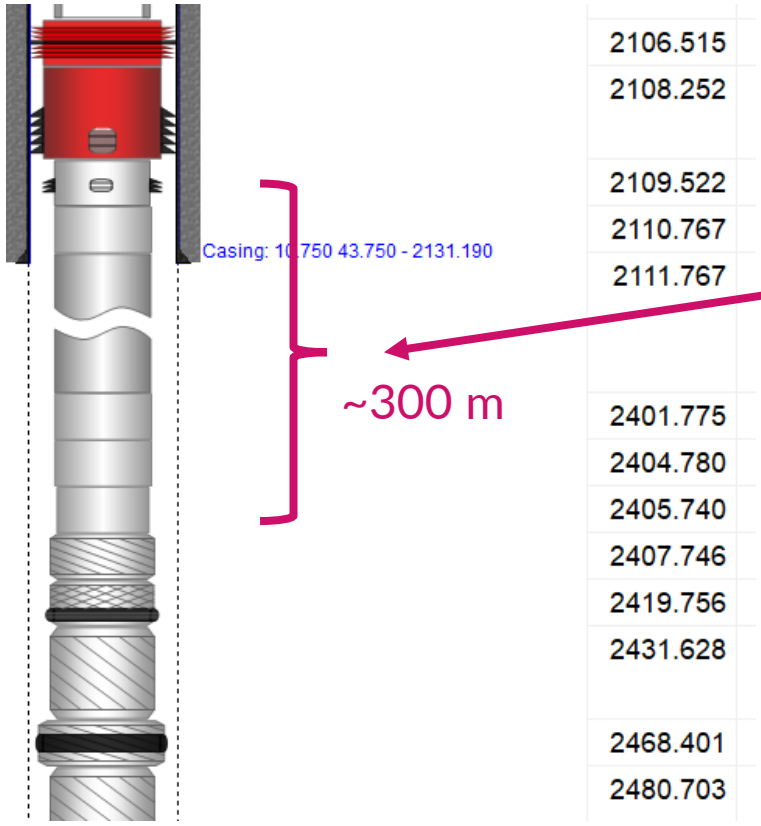


Figure 55 **Simplified geometry for reject flow model**

Experience transfer to wells

Unfavorable design



2106.515
2108.252
2109.522
2110.767
2111.767
2401.775
2404.780
2405.740
2407.746
2419.756
2431.628
2468.401
2480.703

~300 m

Hydraulic Amplifier!

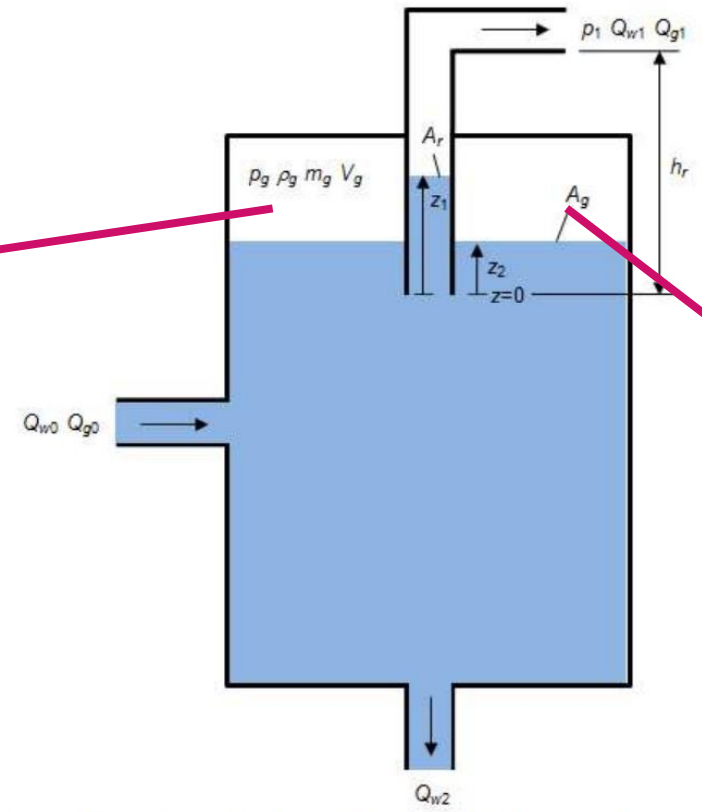
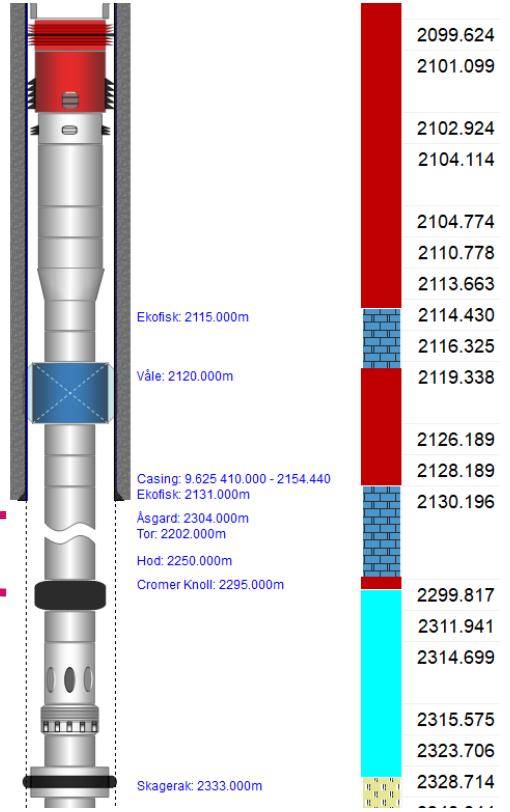


Figure 55 Simplified geometry for reject flow model

Improved design



2099.624
2101.099
2102.924
2104.114
2104.774
2110.778
2113.663
2114.430
2116.325
2119.338
2126.189
2128.189
2130.196
2299.817
2311.941
2314.699
2315.575
2323.706
2328.714

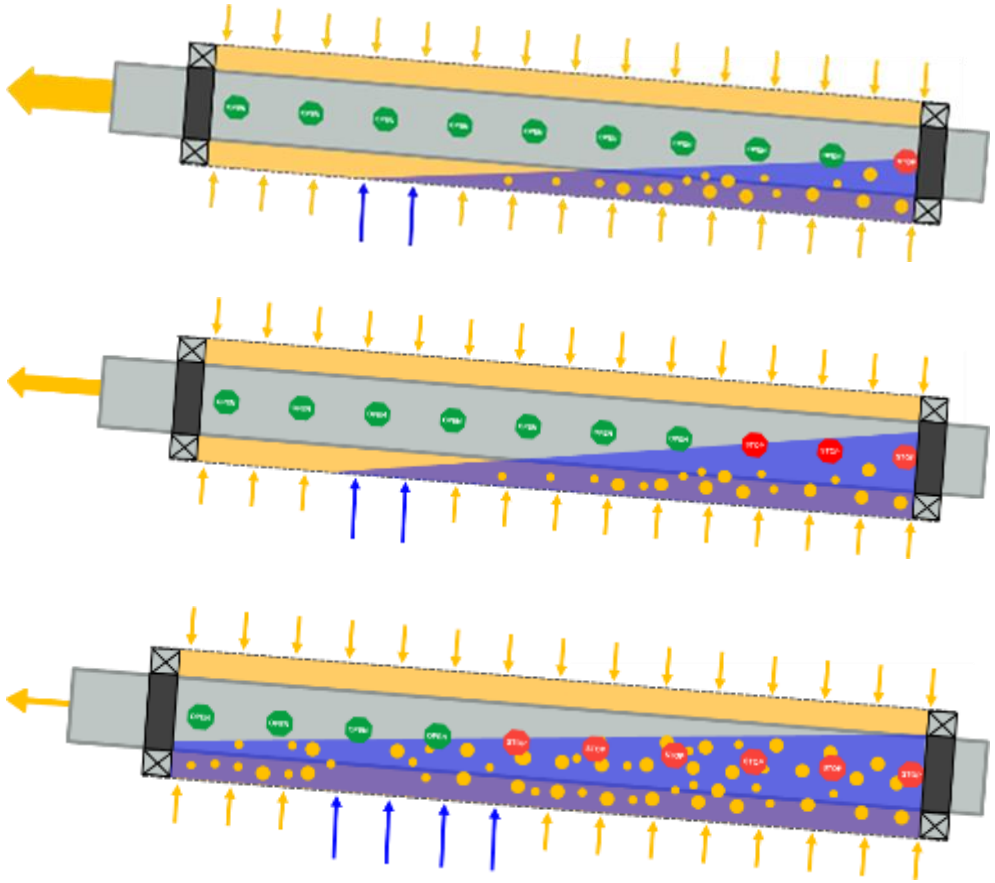
~15 m

Annulus breathing

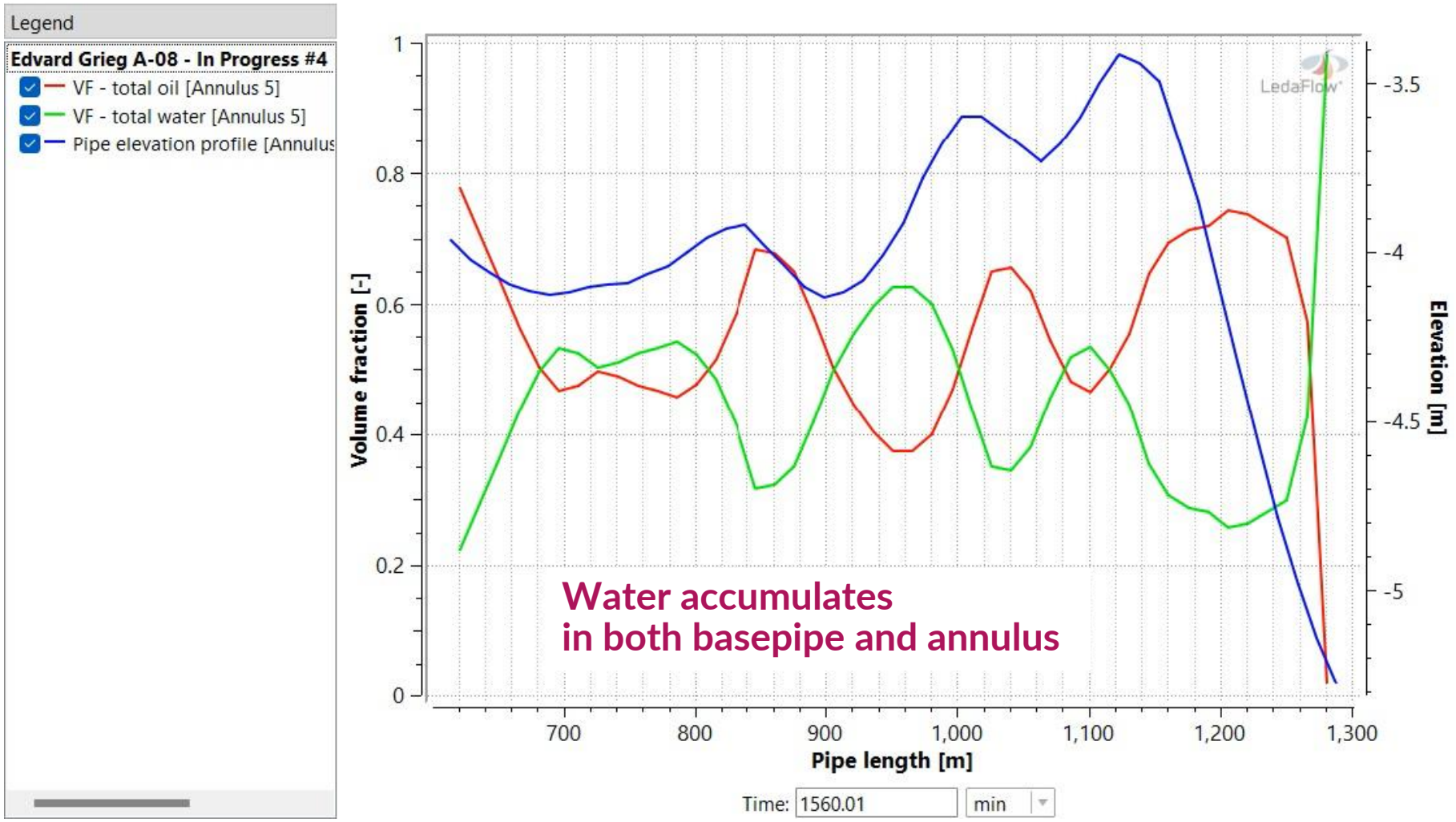
Fluid segregation

It has been documented since 2013 that AICx design must consider the segregation effect that will occur in the outer annulus.

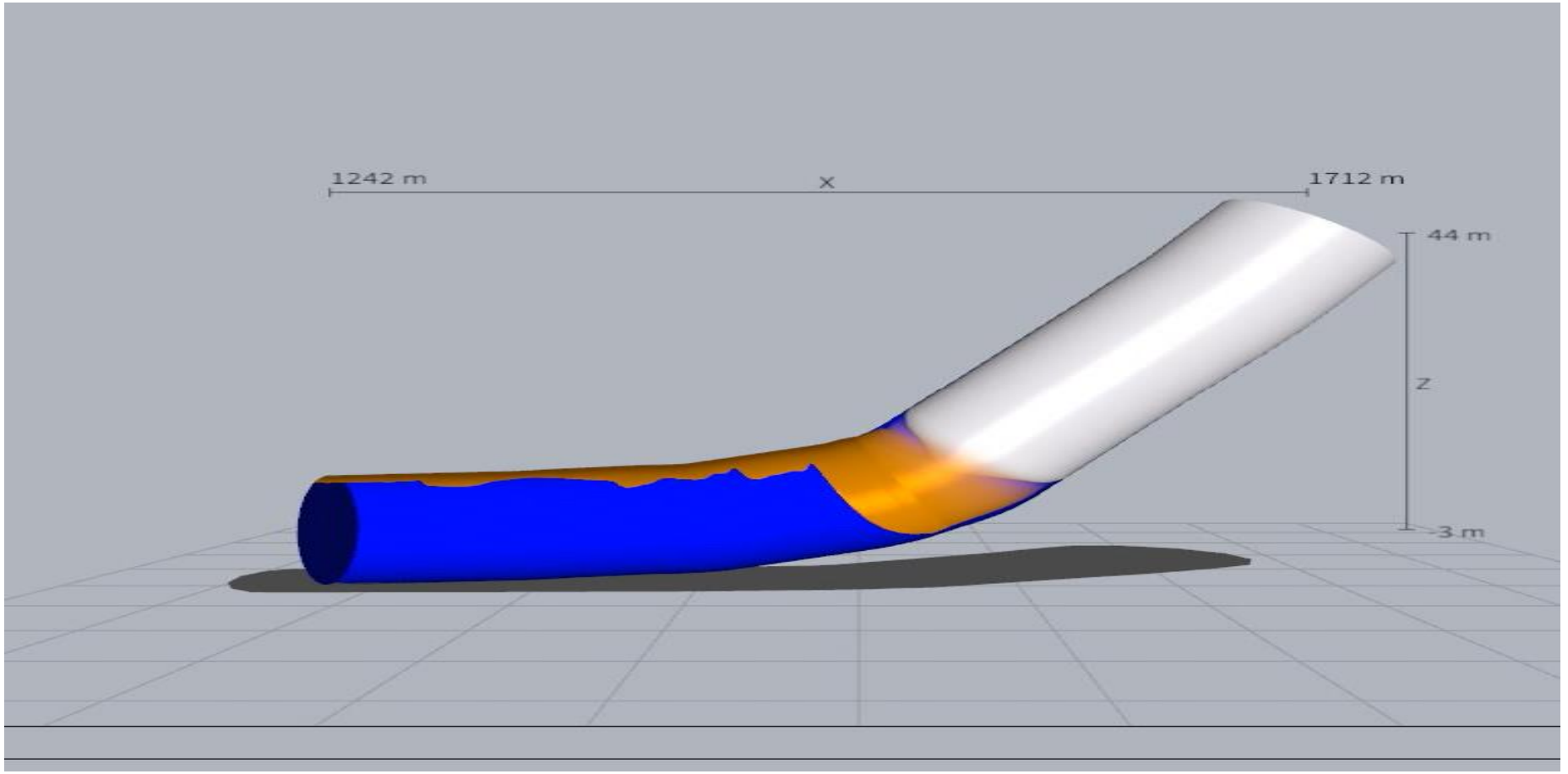
But, what about well stability?



Annulus “breathing”



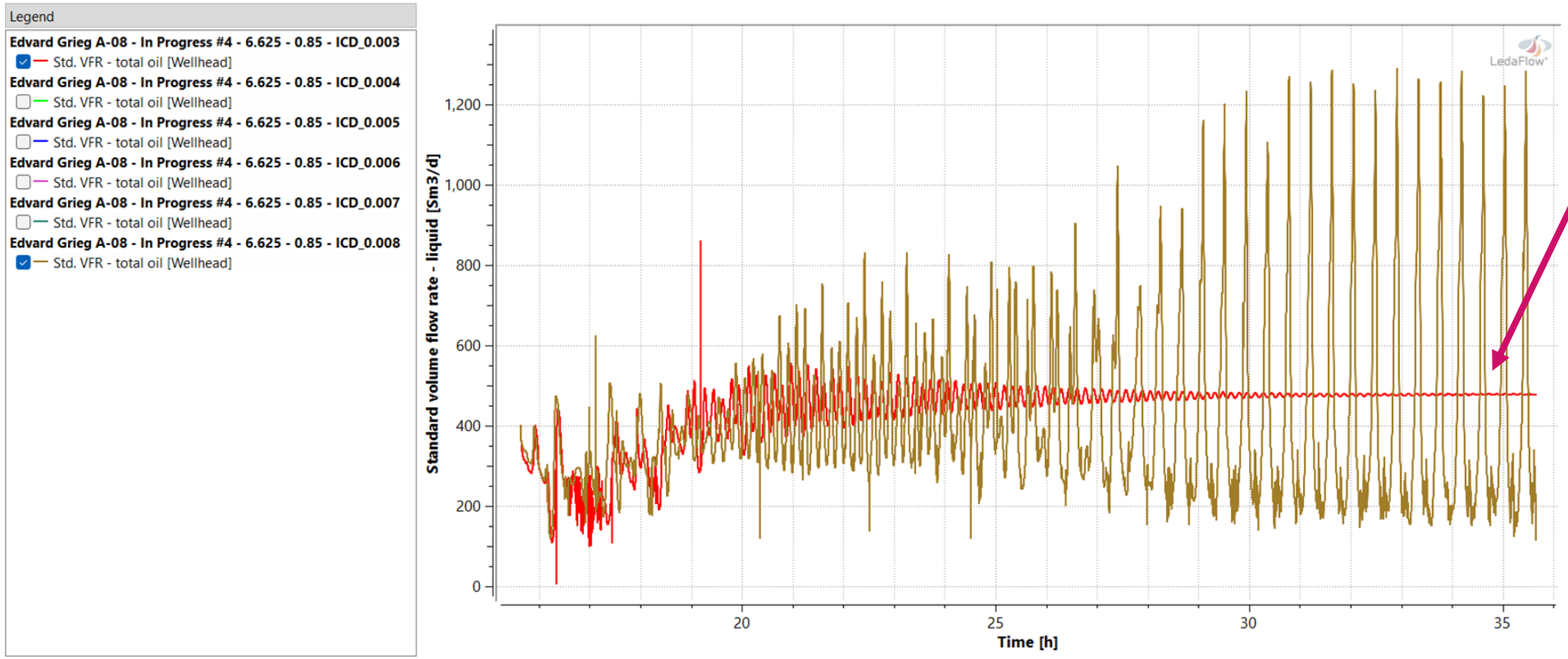
Annulus induced slugging



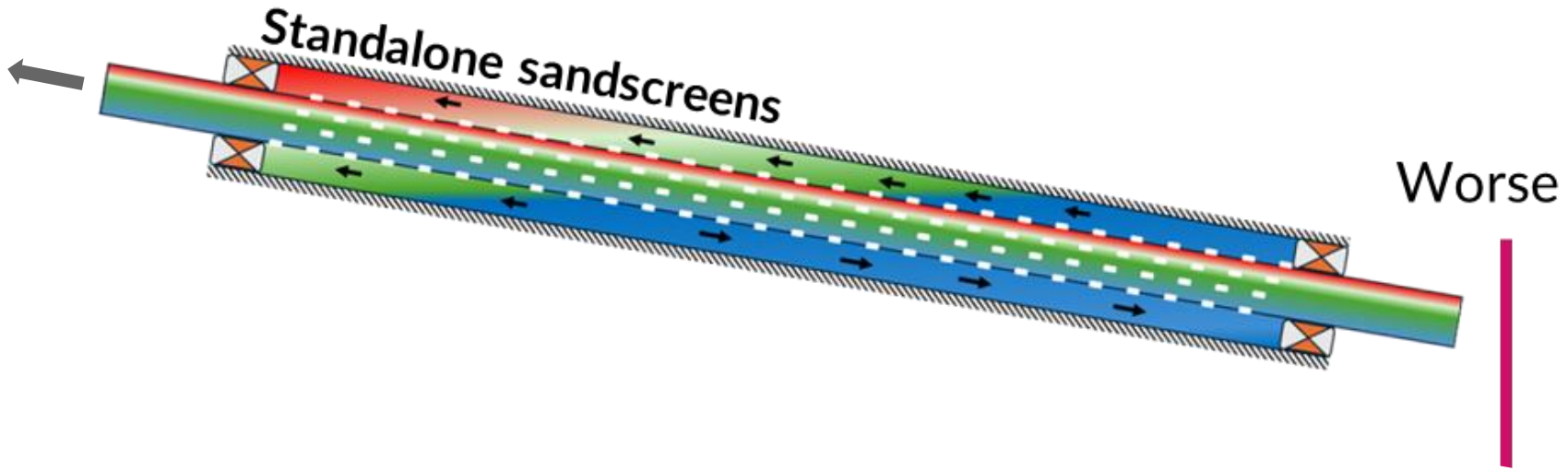
Flow restrictions

Effect of ICD's on well stability – Oil rate (2)

ICD's may contribute to more stable production



Reccomendations for the lower completion



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