Erosion risk and evaluation of screen velocities

EWPF 2025 - Aug 27th

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Outline

- Background
- Sand Control
- Risk and mitigation of screen erosion
- Velocity through screens
- Methodology to estimate velocity through screens
- NETool examples
- Summary

Why do we need sand control in our wells?

Sand control is a safety barrier to reduce risk of erosion and ensure safe production.

Safety – protect production equipment

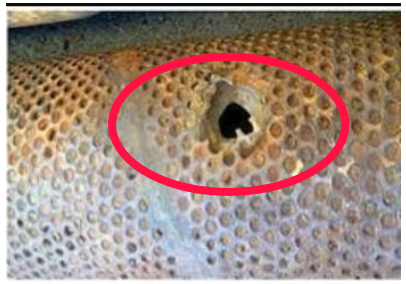
Sand can cause erosion of pipelines, pumps, chokes/valves, filters, screens ++

Clean-up choke

Eroded choke

Topside relief line

Eroded sand screen



Prevent production loss

Uncontrolled sand production can lead to clogging of production equipment; accumulating sand in tubing/well or topside equipment, separators and filters

Sand Control Options

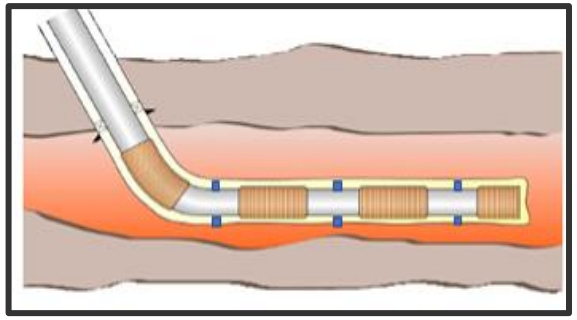
Choice of Sand Control depends on

- Formation strength
- Shale content and permeability
- Particle Size Distribution (PSD)
- Planned well lifetime

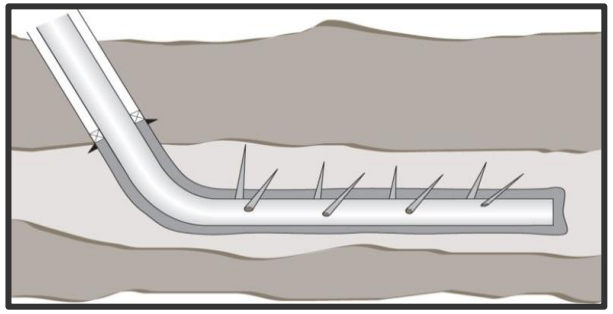
- Well Productivity evaluations
  - Reservoir length?
  - Risk of erosion or plugging?
  - Need for stimulation?
  - Need for inflow control and/or zonal isolation?

Examples of sand control options

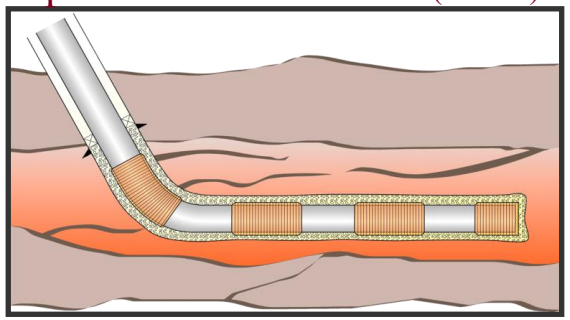
Stand Alone Screen



Cased Hole Perforation *(oriented & selected)*



Open Hole Gravel Pack (OHGP)



Other Sand control options

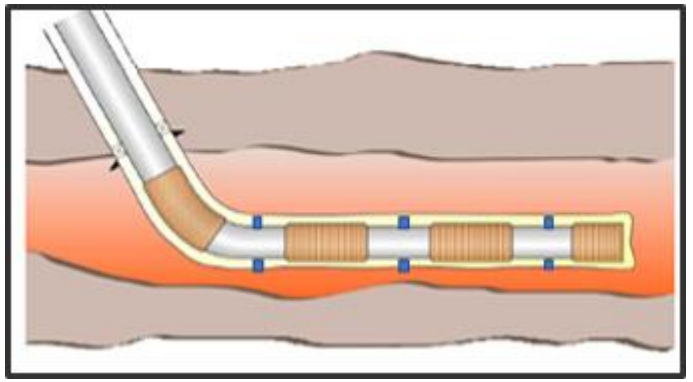
- Cased Hole Frac Pack (CHFP)
- Cased Hole Gravel Pack (CHGP)

Equinor approach to selecting sand control method

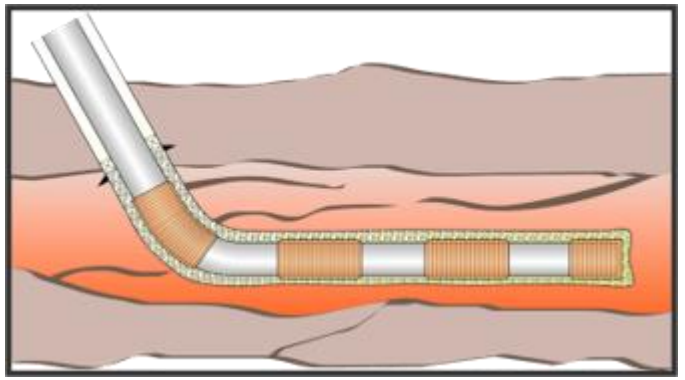
"If sand control is found to be necessary, the standard open hole solution is a stand-alone screen (SAS).

- *However, open hole gravel packs (OHGP) may be the preferred choice due to reservoir properties or flow conditions*
  - *Depending on the screen aperture size required to restrict sand production*
  - *Presence of silty or shaly layers and the possibility of isolating those layers*
  - *Risk mitigation for high-rate wells (high velocity through screens)*

Stand Alone Screen (SAS)

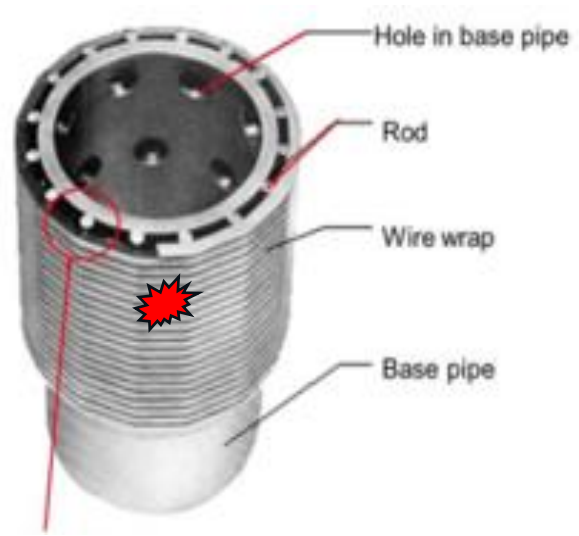


Open Hole Gravel Pack (OHGP)

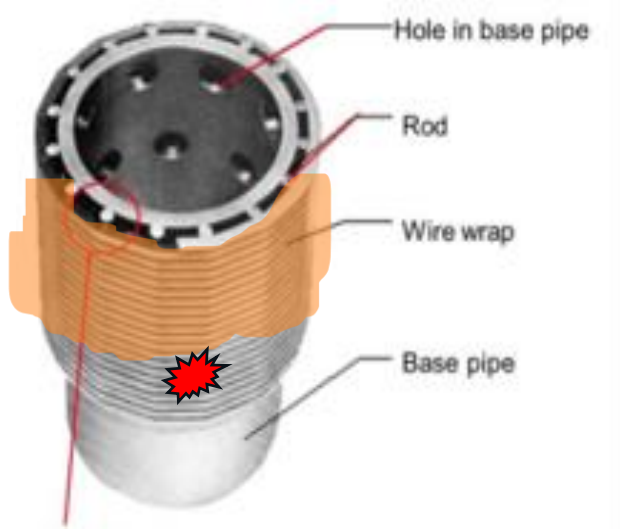


Risks and Sand control screens

- Uncontrolled sand production **may occur** if:
  - Screens are **damaged during completion** (mechanical damage)
  - Screens are **eroded**
    - **Particles present and high velocity**
    - **Plugging, leading to high velocities and erosional failure**



High velocity and particles → eroded hole



Plugging → Higher vel → hole

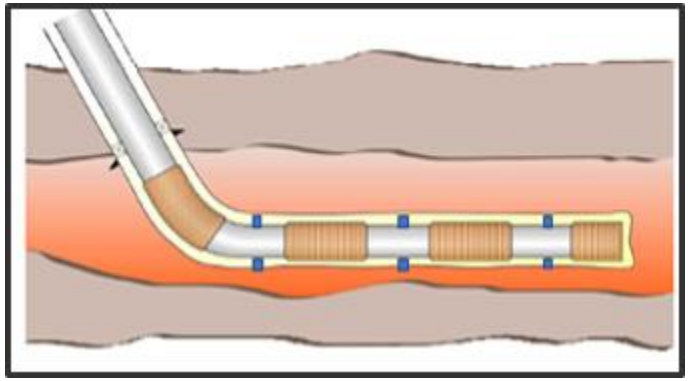
(hot spotting)

How do we mitigate risk of sand production due to screen erosion?

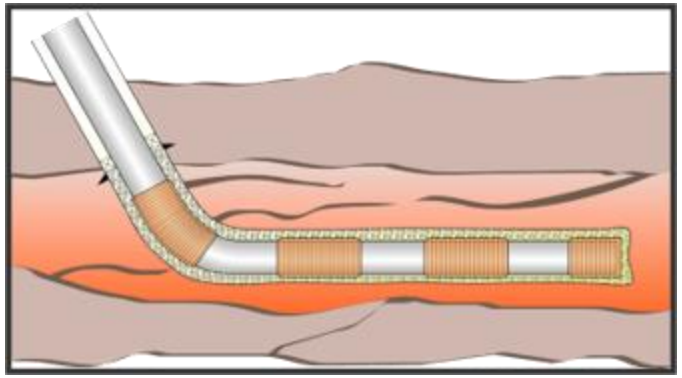
Methods to mitigate screen erosion

- Gravel packed annulus (OHGP completion)
  - Reduce particle transportation and velocity in annulus
  - Forces radial flow and removes high axial flow and potential for high velocities at heel
- Lower Completion design
  - Inflow control technologies
  - Screen design; size, base pipe holes, materials
- Hole and well cleaning pre/during installation
  - Reduce particles in well/annulus
  - Reduce risk of screen plugging
- Isolate shale intervals by use of blanks and open hole packers
  - Reduce particles (transport) in annulus
  - Reduce risk of screen plugging

Stand Alone Screen (SAS)



Open Hole Gravel Pack (OHGP)



Erosion risk, what determines the limit for a ‘too high velocity’ ?

- Challenging to define a universal criteria that covers all possible scenarios
  - Impact parameters: particle size, amount & type of particles, fluids & viscosities, pressure, temperature, completion design.. i.e.

- Based on available experiences in Equinor, in the industry and technical evaluations, the following is recommended by Equinor:
  - A velocity limit to evaluate the risk of screen erosion.
  - A practical approach that can be evaluated during well planning and monitored after wells are put in operation.

Velocity across screen	Risk of failure
<1 m/s	Low risk of screen erosion
1-3 m/s	Moderate risk where screen failure is likely within 1-2 months
>3 m/s	High risk of instant screen failure

Table 1 Risk of un-protected sand screen failure at different velocities through screen. NB! The velocity limits above are valid when particles are present in flow.

  - Equinor acknowledge that other parameters also impact the probability of screen erosion,

Which velocity do we refer to when calculating the velocity across screens?

- Note that the velocity of interest is the **velocity through filter** (wire wrap or mesh) perpendicular (radial) to the base pipe, ref **red colored** arrow in the figure below.

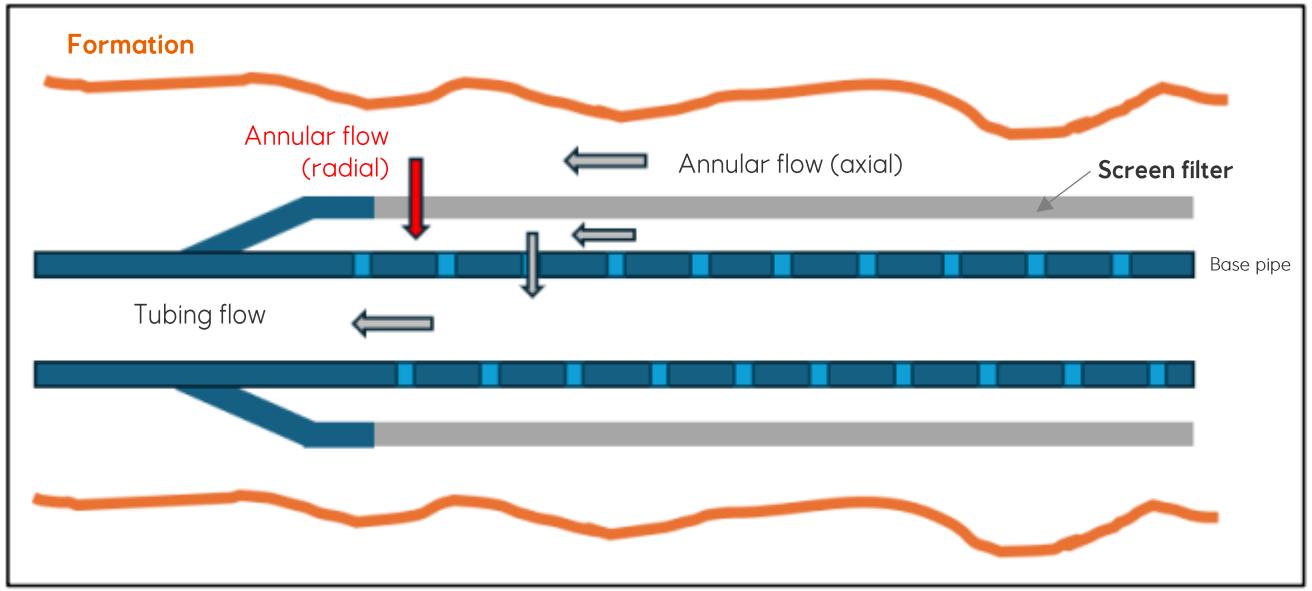


Figure 1. Velocity across sand screens. The velocity considered is the radial velocity component through the screen jacket.

Velocity across Sand Screen

Methodology

Methodology to estimate the representative velocity through screens is used in well planning and operation:

- Evaluate risk of screen erosion/hot-spotting
  - Gas producers or high-rate oil producers
- Impact of open or packed annulus

A NETool methodology chosen based on

- Easy to calculate
- All engineers can do the calculation
- Flexible solution for comparing completion solutions

NETool

- Near wellbore & completion simulator
- Steady state

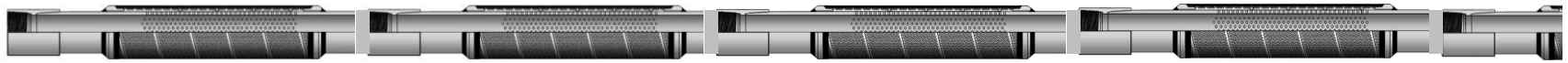
Input data for screen velocity calculations in NETool

The following screen parameters are mainly affecting the calculated velocity:

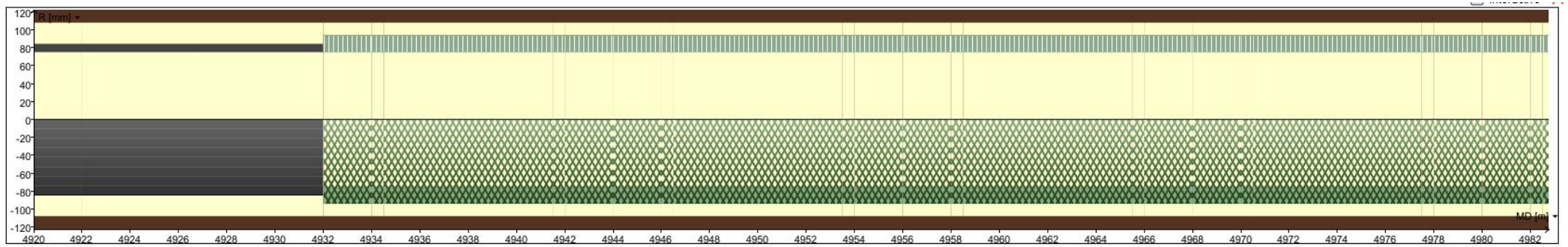
- Base pipe inner diameter
- Screen/filter outer diameter
- Diameter of holes in base pipe
- Number of holes in base pipe (holes/m)
- Percentage of mesh/wire wrap open to flow and/or flow area open to flow

Screen set-up in NETool

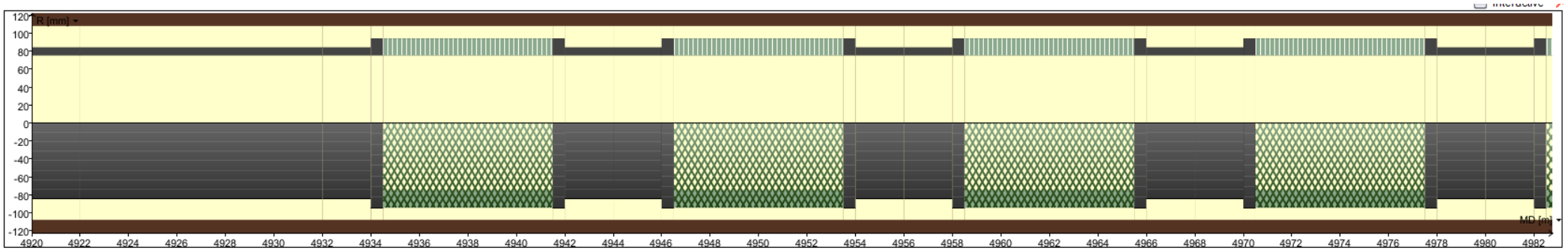
Actual Screen configuration is complex – NETool may be defined with a variety of details



- Simplified



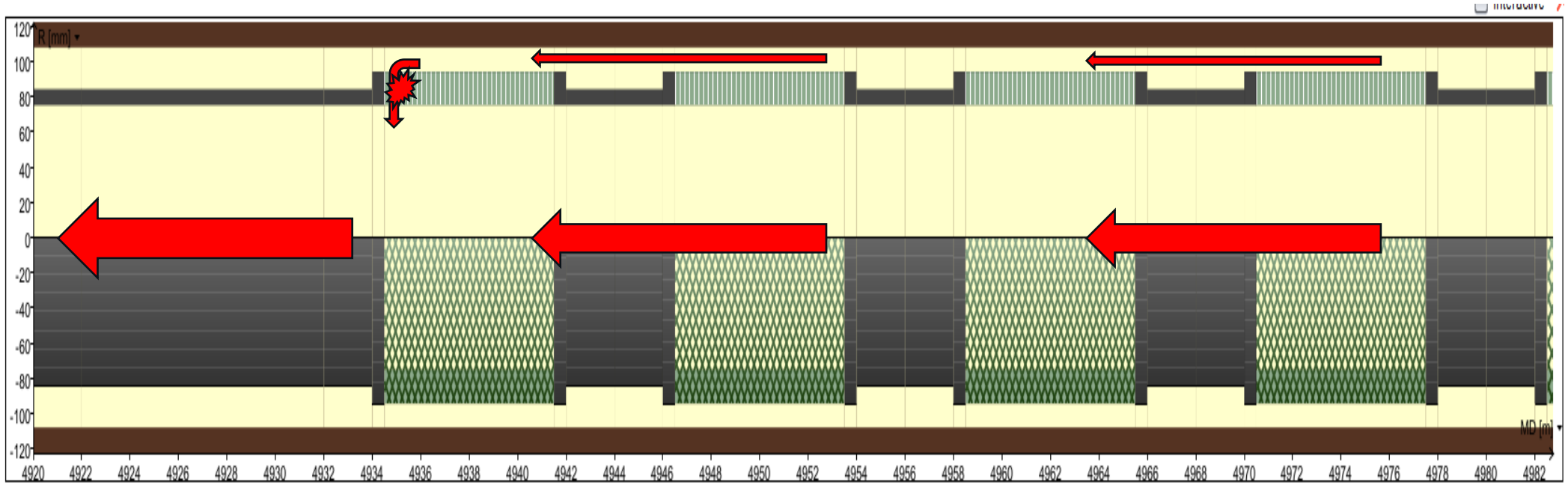
- Normal



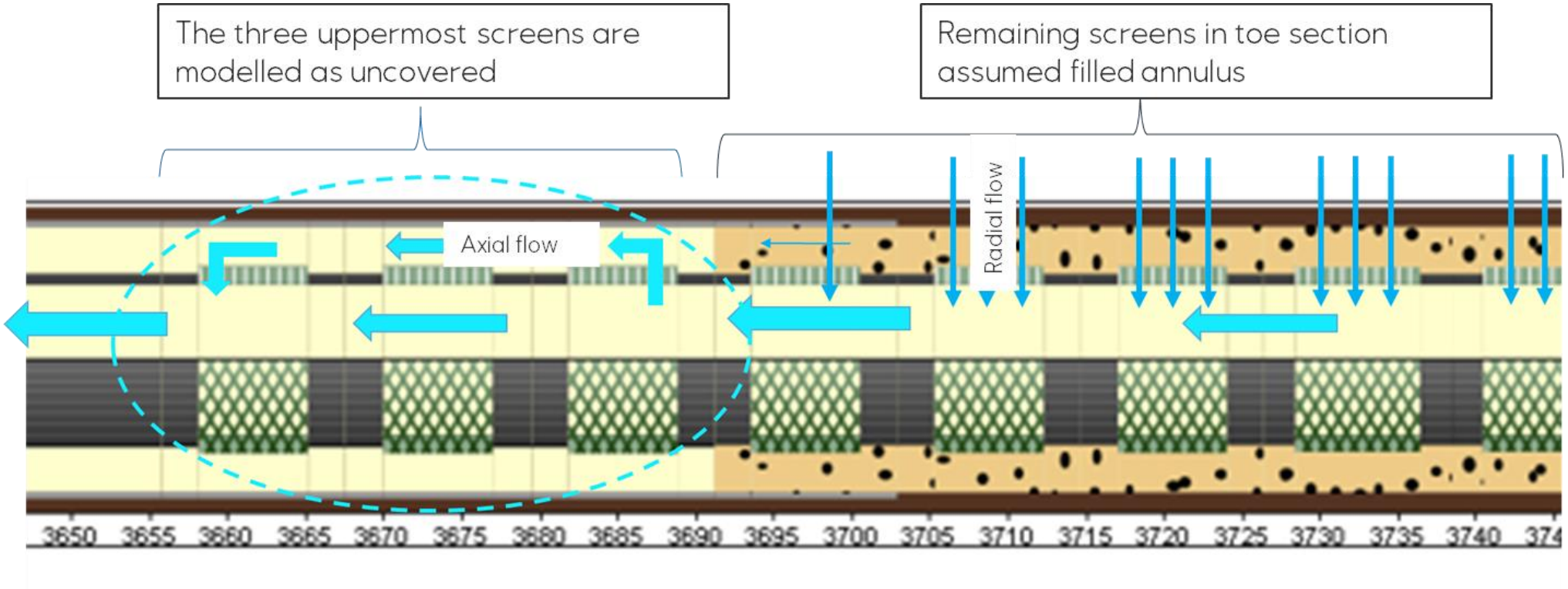
Note: Maximum resolution for NETool calculations (0.1m) selected while studying velocity through screens.

Flow paths in lower completion

Focus influx at top of uppermost screen



Flow paths in lower completion

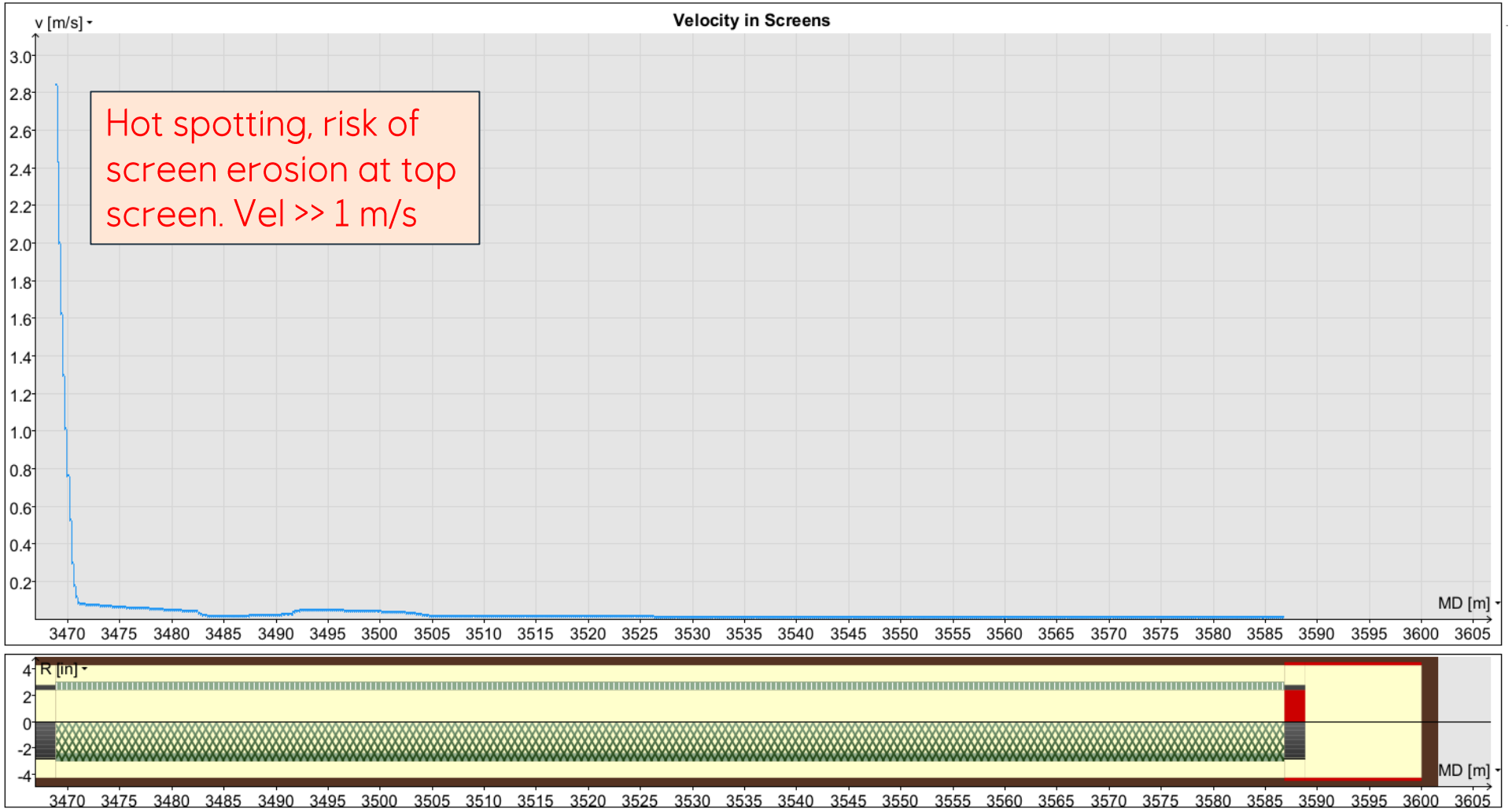


High risk of screen failure if unsuccessful gravel pack and high rate!

NETool examples

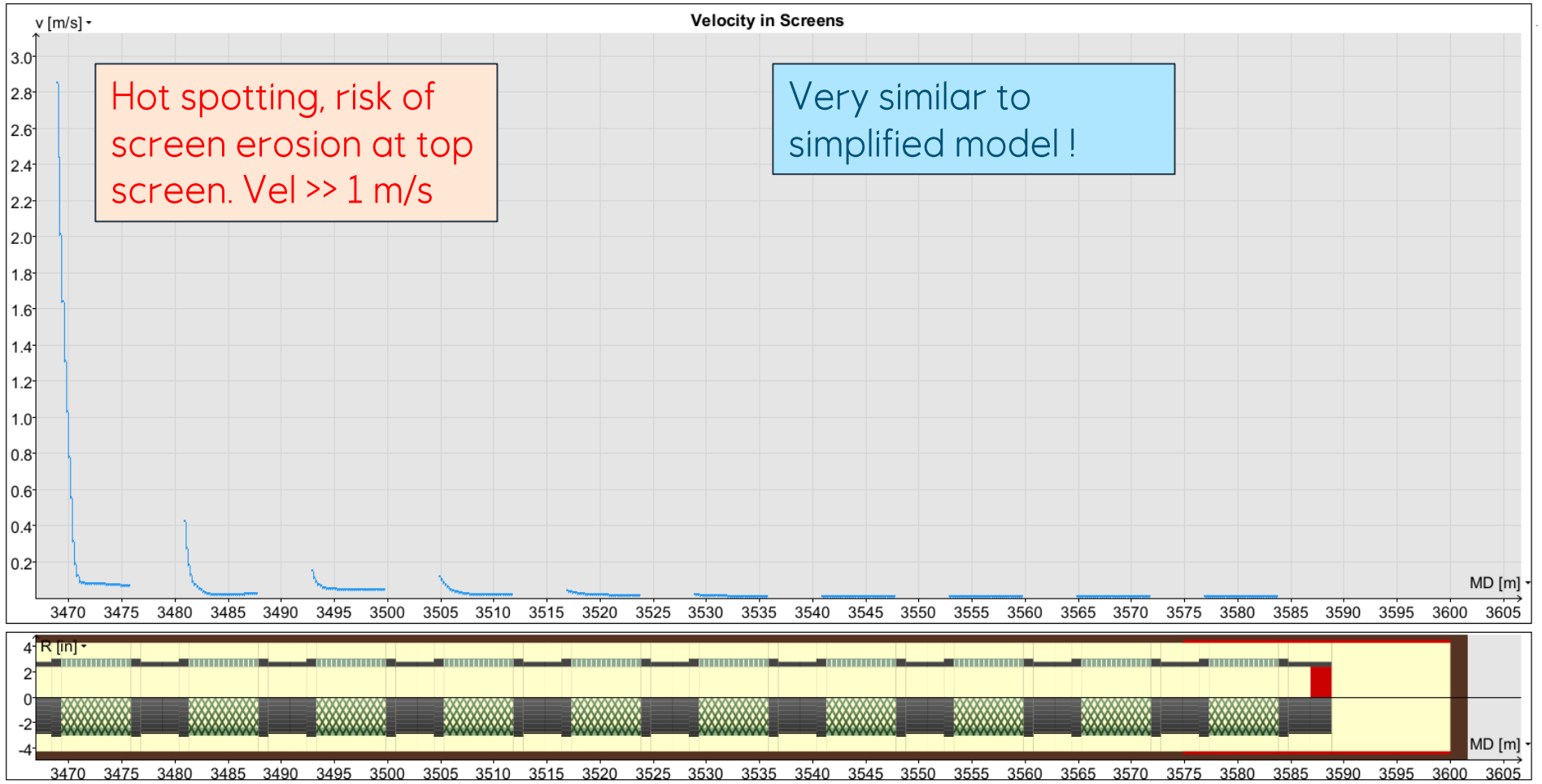
- SAS screens (simplified)
- SAS screen (normal)
- SAS screen (normal & larger screen size)
- SAS screen with gravel in annulus (OHGP)
- SAS screen (base pipe modified)

Gas producers with SAS screens | Example: Simplified NETool model 5.5 inch



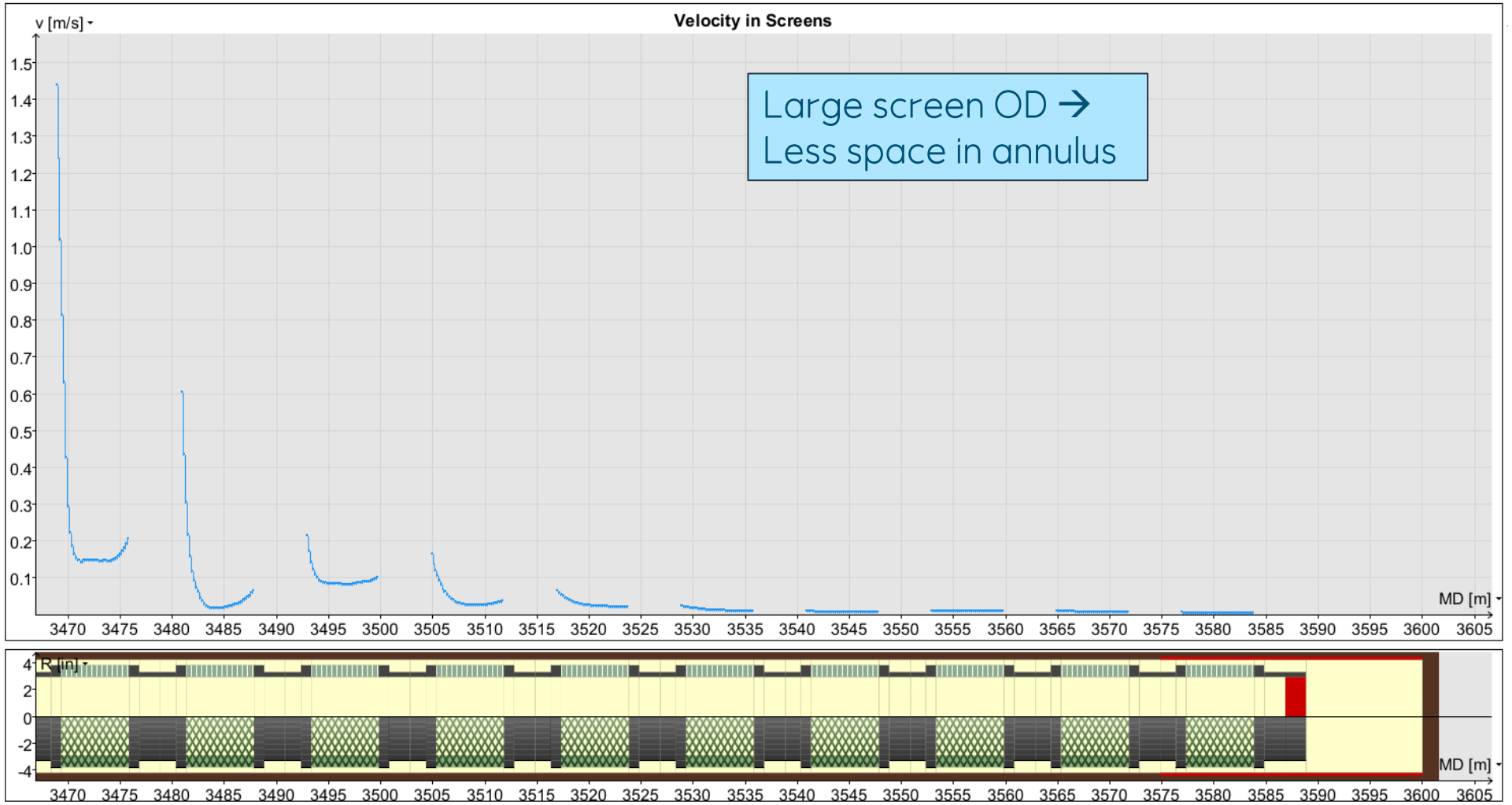
- Gas rate : 2.5 MSm3/d
- **Max velocity: 2.8 m/s**

Gas producers with SAS screens | Example: Normal NETool model 5.5 inch



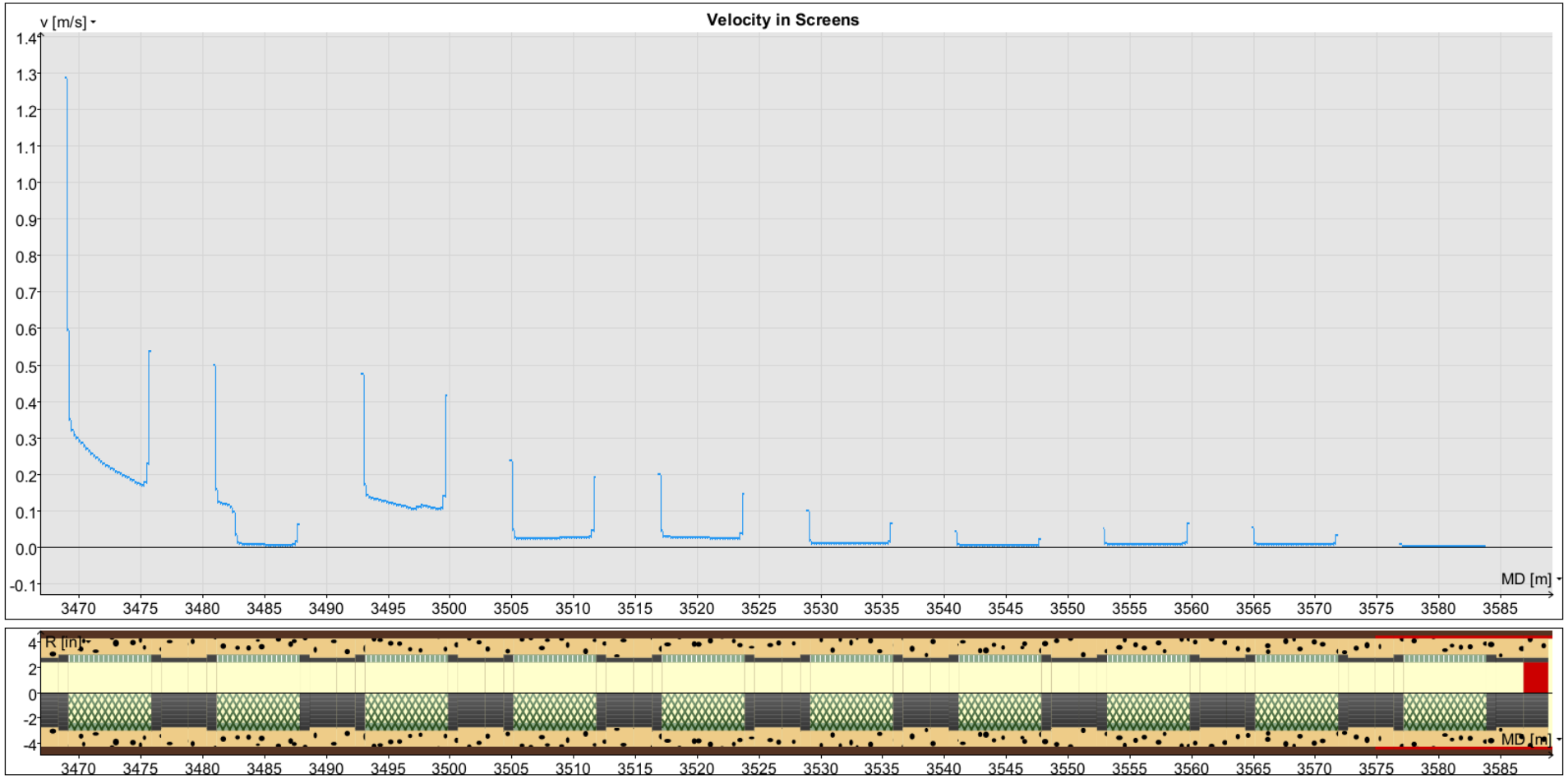
- Gas rate : 2.5 MSm3/d
- **Max velocity: 2.8 m/s**

Gas producers with SAS screens | Example: Normal NETool model 6 5/8 inch



- Gas rate : 2.5 MSm3/d
- **Max velocity: 1.4 m/s**

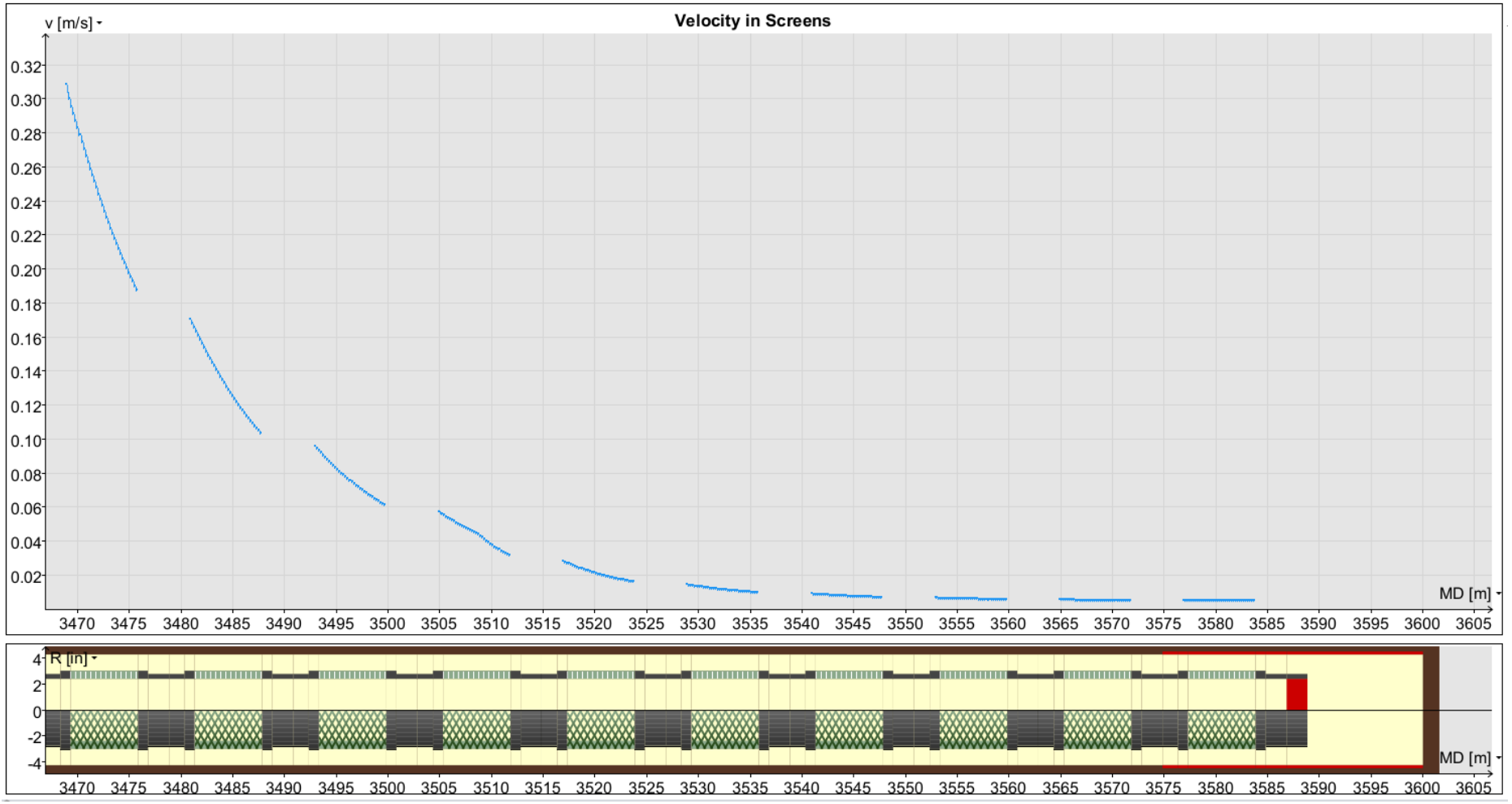
Gas producers with screens | Example: OHGP



- Gas rate : 2.5 MSm3/d

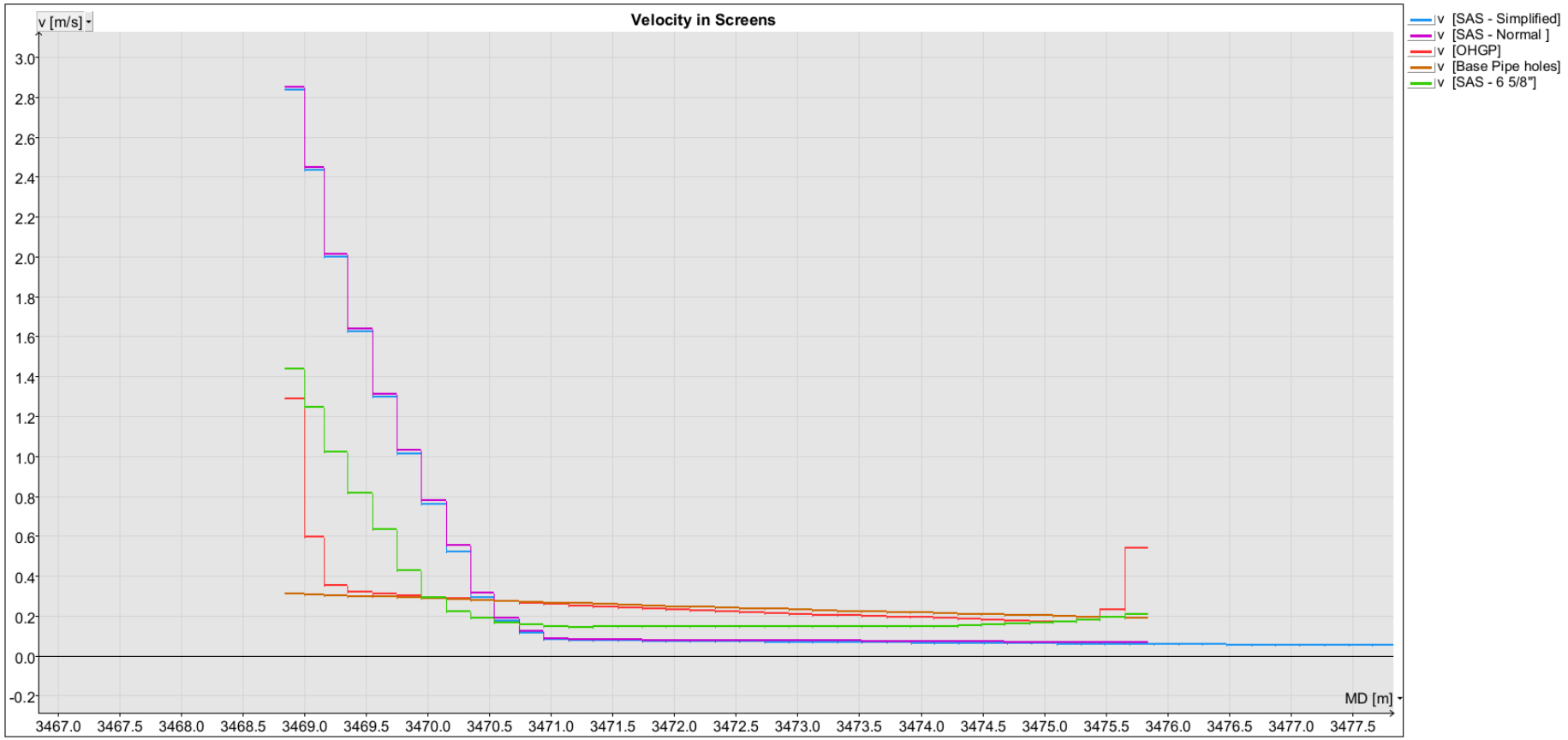
- Note:
- Successful OHGP
  → No velocity limit

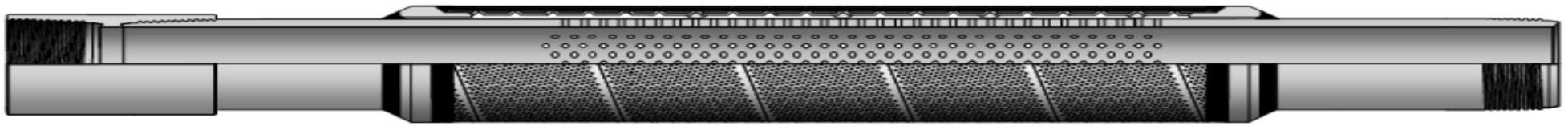
Gas producers with screens | Example: High rate gas screens



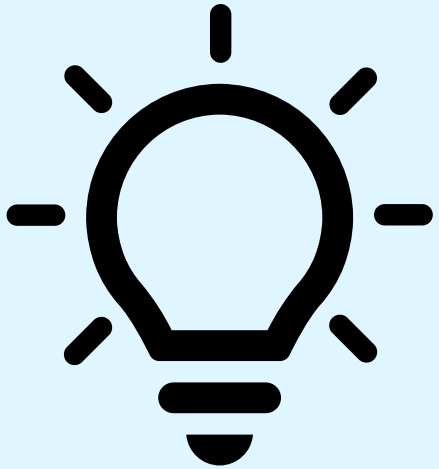
- Gas rate : 2.5 MSm3/d
- **Max velocity: 0.3 m/s**

Summary – NETool simulations





Summary



- Map & Evaluate risks
- Understand risks and mitigating options
- Use simulations to better understand and quantify the risk
- Run sensitivities to evaluate mitigating actions
- Use simulations to evaluate flow paths and pressure drop within the lower completion to improve completion design and optimize production

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