CHAM Case Study – CFD Simulation of a Water Extraction Pumping Station, by Katarzyna Bozek, RHDHV Scientist, Water Europe, and Timothy Brauner, CHAM, London.
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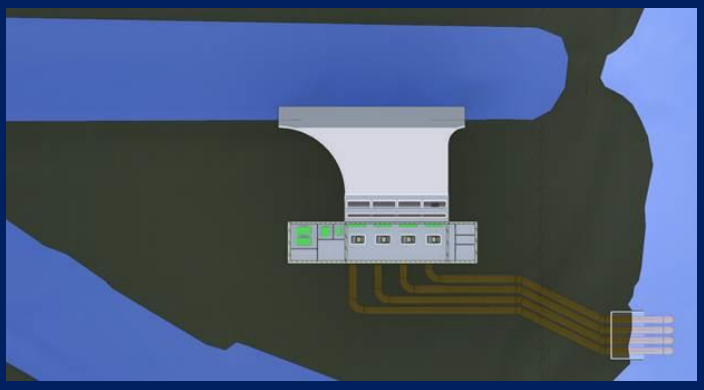
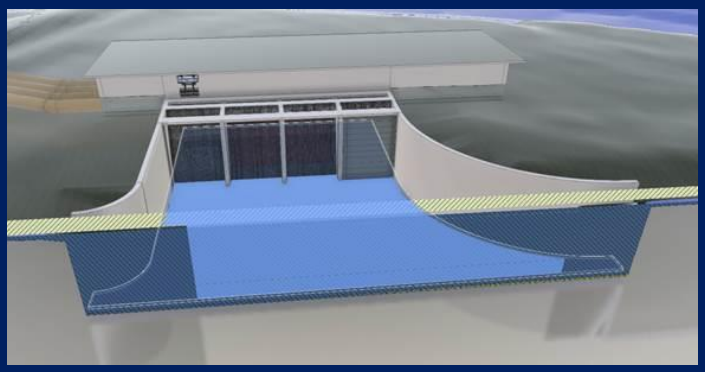
Haskoning DHV Limited, a division of the Royal Haskoning DHV Group, approached CHAM for assistance in predicting the operation of a new pumping station being designed for a planned development in the Middle East. The objective was to model water entering a pumping station from the approach channel/forebay, through an intake and past dividing walls that separate four pumps. Two orientations of the pumping station were considered; the first angled at 90^{o} to the channel, and the second angled at 30^{o}.

The purpose of the exercise was to compare the two proposed designs by reviewing the 3D velocity field approaching the pumping station, through the intake bend and fine eel screens and finally through separation walls to the pumps.



Pumping Station schematic Plan View and eel screens



Pumping Station schematic with intake bend

The CFD model was created using CAD input for the approach channel and each pumping station orientation. The cases were run as single-phase, steady-state models, with the upstream water level and downstream pump capacity both fixed (and taken from other modelling data). The CFD model ended downstream of the pump intakes at four abstraction points before the pipes.

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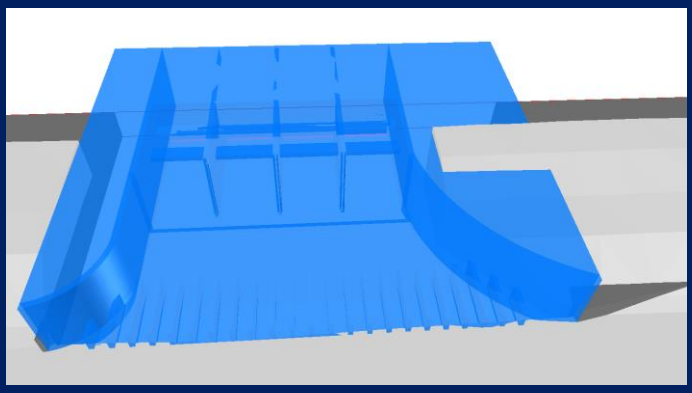
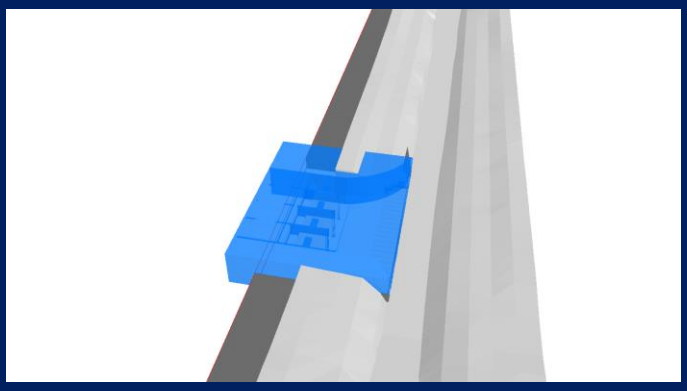


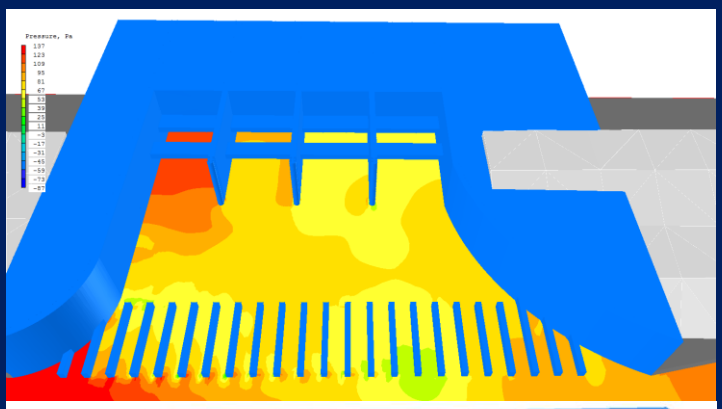
Pumping Station CAD import



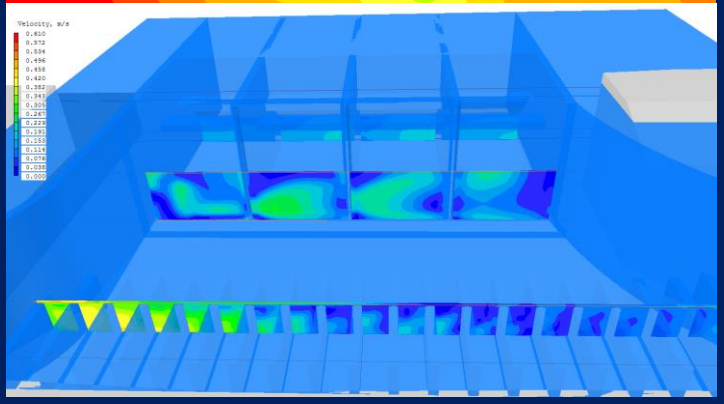
Pumping Station CAD import with approach channel

The initial case studied the water flow without the eel screens in situ. The case used a grid of 800,000 cells and took less than 2.5 hours to run to convergence on a 3.4GHz quad-core PC with 16 GB RAM.

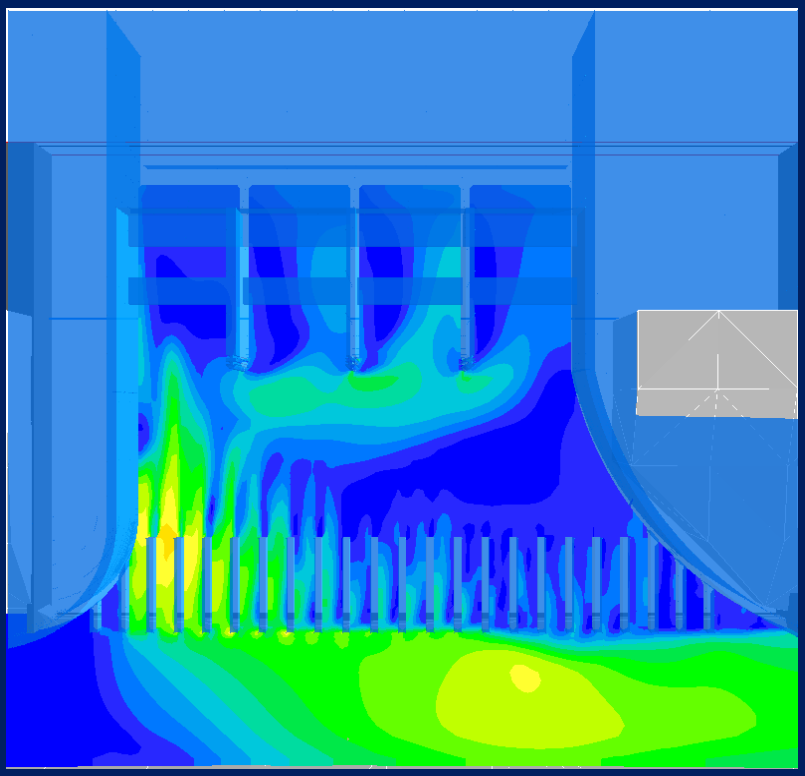
The result for the 90^{o} angle shows the not-unexpected imbalance in water pressure and velocity has been tempered only slightly by the preceding guide channels.



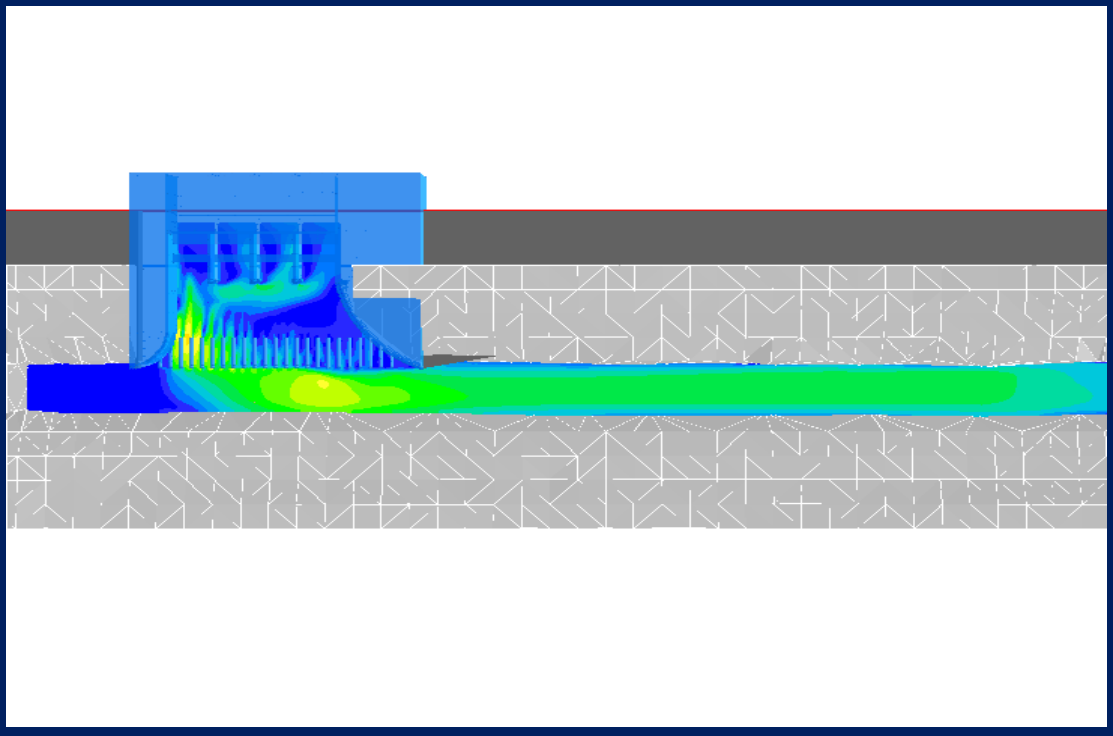
Pressure Z3.3m depth



Velocity Y slices

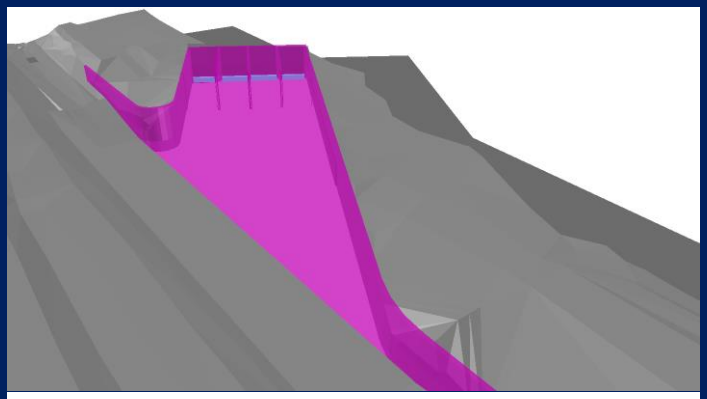


Velocity Z3.3m depth
Plan View

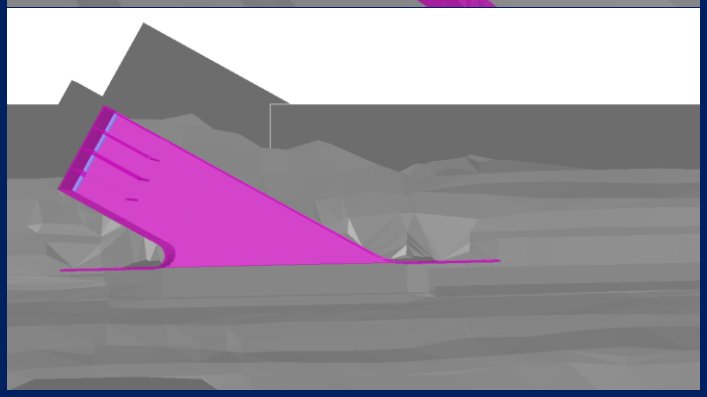


Velocity Z3.3m depth including approach channel

An alternative orientation for the pumping station to the channel was investigated; this involving a 30^{o} angle to the channel, as shown below:

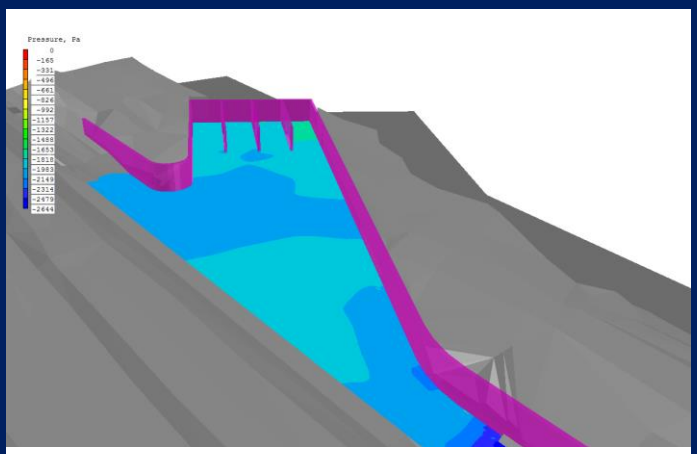


Pump Station re-positioned at a 30^{o} angle

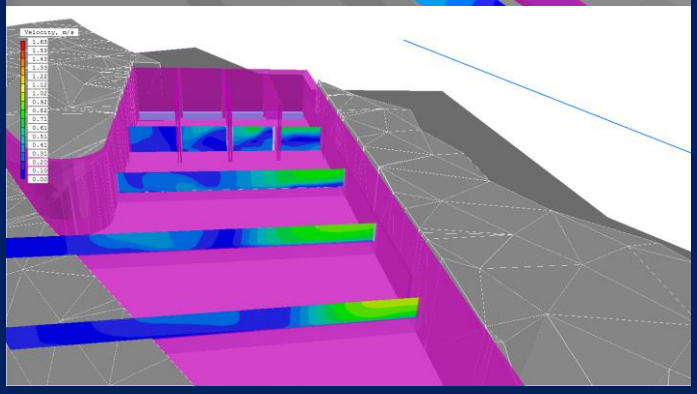


Pump Station with approach channel

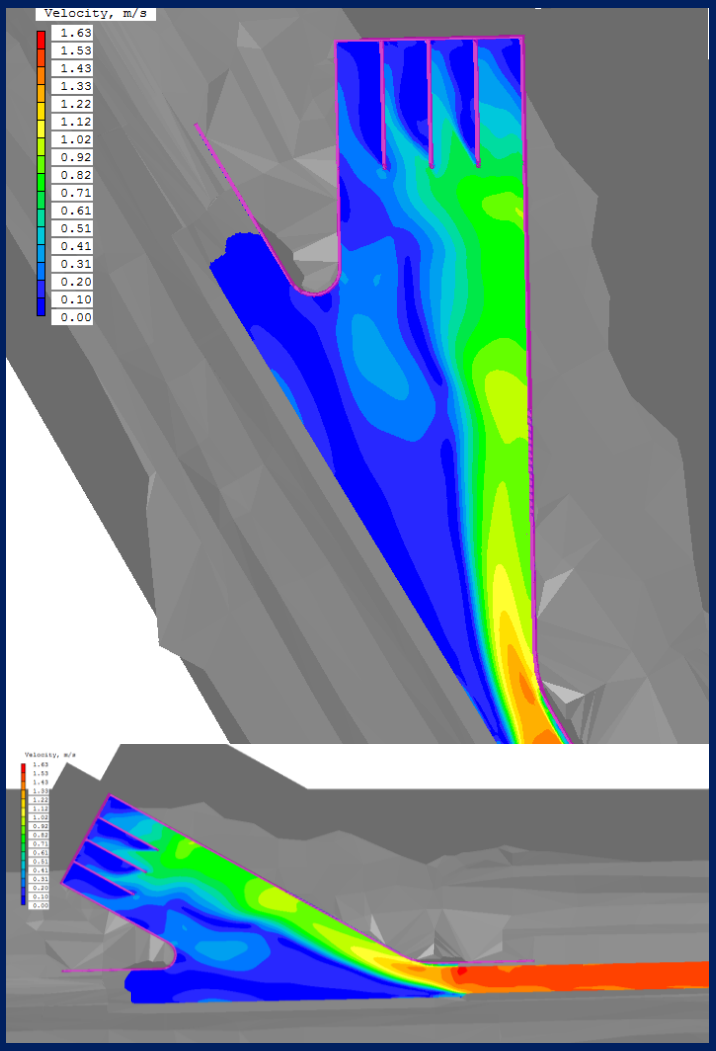
The expectation being to spread the incoming water flow evenly across the four pumping outlets.



Pressure Z3.3m depth



Velocity Y slices



Velocity Z3.3m depth Plan View

Velocity Z3.3m depth with approach channel

Again, this preliminary 30^{o} rotated design shown proved to be only partially successful. The pressure is certainly more uniform, yet the water flow becomes accelerated towards one side of the channel.

This particular design did not employ guide vanes as were installed in the previous CFD model. These were subsequently re-instated by the client and adjusted for optimum performance during their next stage of design investigations – once again demonstrating the cost- and speed- benefits of using trial-and-error CFD simulation ahead of physical modelling or full-scale construction.

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