

DHI CASE STORY

# REDUCING THE HAZARD OF SEWAGE OVERFLOWS

## Using CFD to minimise sewage and storm water contamination of the environment

Like many large cities, the storm water runoff and sewage of Aarhus, Denmark, flow together in a combined drainage system. When a big storm hits the city, some of the excess wastewater goes to the Trøjborg retention basin for storage, until the wastewater treatment plant is able to process it. The Trøjborg basin, however, is situated near the Aarhus Harbour – a popular swimming site. During a severe storm, the contaminants from the wastewater may spill from the basin into the harbour. As part of a research project, we used Computational Fluid Dynamics (CFD) to examine the ability of the Trøjborg basin to settle contaminants in the wastewater. Furthermore, we investigated ways to improve the settling efficiency of the retention basin.

### PROTECTING THE BATHING WATERS OF AARHUS HARBOUR

The Aarhus Harbour in Denmark is a popular bathing spot for the city's 300,000 inhabitants. Located near the harbour, is the Trøjborg retention basin. This retention basin is used to store excess storm water and sewage when there is a storm or an event that causes a higher than normal inflow. The untreated water is later pumped back to a plant for treatment before being discharged.

*The construction of the Trøjborg retention basin with spill structure in Aarhus, Denmark (left). The finished basin situated beneath a recreational park (right). © DHI*



### SUMMARY

#### CLIENT

Collaboration with the Water Supply and Sanitation Technology Platform (WSSTP) – a thematic working group dealing with sustainable water management in urban areas

#### CHALLENGE

Contamination of waterways, coastal areas and the environment by storm water and sewage during severe storms in cities

#### SOLUTION

- Using Computational Fluid Dynamics (CFD) to understand flow and sediment dynamics in retention basins (basins used to store excess wastewater before treatment) containing both storm water and sewage
- Testing various design options with CFD to improve how well sediments settle in retention basins

#### VALUE

- Verification of how well sediments settle in a retention basin during the design and planning stages
- Optimisation of existing retention basins
- Improvement in the effectiveness of settling sediments, thereby reducing contaminant spill

#### LOCATION / COUNTRY

Aarhus, Denmark

Like many large cities, the sewage and storm water runoff from Aarhus flow together in a combined drainage system. Trøjborg retention basin receives this wastewater, which includes sediments in the combined sewage and storm water. Although the Trøjborg retention basin has a capacity of 16,000m$^3$, this capacity may be exceeded during severe storms . In such an event, contaminants will overflow into Aarhus Harbour.

Therefore, we examined ways to improve the design of the Trøjborg retention basin to increase the settling of sediments in the tank as part of the Water Supply and Sanitation Technology Platform (WSSTP) research project. Enhancing the tanks settling efficiency will reduce the contaminants which spill into the Aarhus Harbour in an overflow situation.

## OPTIMISING TRØJBORG RETENTION BASIN

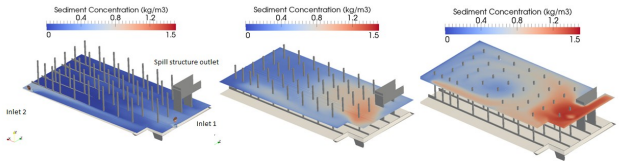
We examined ways to reduce the amount of contaminants from the retention basin spilling into the harbour during a storm. Using CFD modelling allowed for a detailed understanding of fluid mechanics in the basin. By understanding the flow field, we could make improvements in the ability of basins to settle sediments.

The basin's ability to settle these sediments depends on several factors, including:

- the profile of the sediment in the inflow
- the inflow rate
- the geometric features of the basin and spill structure

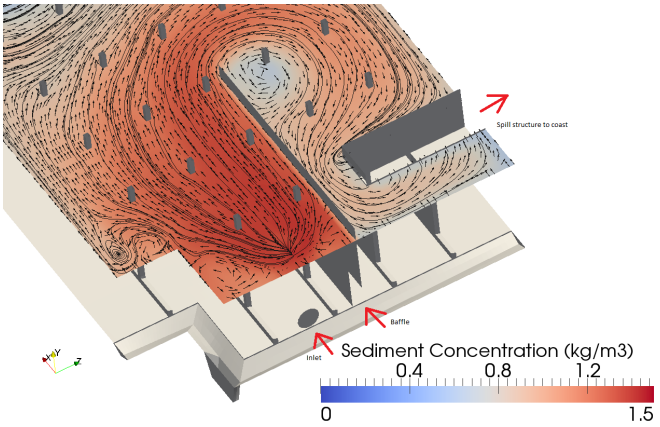
We used CFD modelling to calculate the 3D dynamics of the flow field within the retention basin during the filling and overflow stages. We then assessed:

- streamlines of the flow paths
- sediment concentration contours
- the quantity of spilled contaminants




*Plots of the free surface with sediment concentration for three stages of the filling of the retention basin at 500 seconds (left), 4,000 seconds (middle) and 8,500 seconds (right). ©DHI*

By examining critical variables (such as overflow concentrations in a high inflow situation), we can compare the settling effectiveness of various basin designs. For the Trøjborg retention basin, we found that there is a short flow path between the basin inlets and the spill structure, allowing for a high concentration of sediments near the outlets.




*Close up of contour plot near the free surface for the model with a baffle included. The model has been spilling for 500 seconds. Surface vectors and streamlines show the location of the attachment of the inflow jet as well as the flow path around the baffle to the spill outlets. © DHI*

In order to lengthen the flow path, we suggested adding baffles (flow directing panels) to the retention basin. This gives the sediments more time to settle, increasing the settling efficiency of the tank and decreasing the amount of sediments that spill out when the basin overflows.

### TAILOR-MADE CFD MODELS

CFD modelling can be used to verify designs for a particular site during the design phase as well as to optimise existing installations. The details of the CFD model can be tailored to suit individual needs, based on:

- the available data
- the number of scenarios/design cases to be performed
- the level of flow resolution needed

With several decades of experience in modelling and monitoring urban drainage systems, we have the knowledge to build and interpret detailed numerical models, providing assessments with engineering value.



Contact: Xerxes Mandviwalla – xem@dhigroup.com
For more information visit: www.dhigroup.com