# Hydrodynamic modelling of STW

## designed to increase capacity

by
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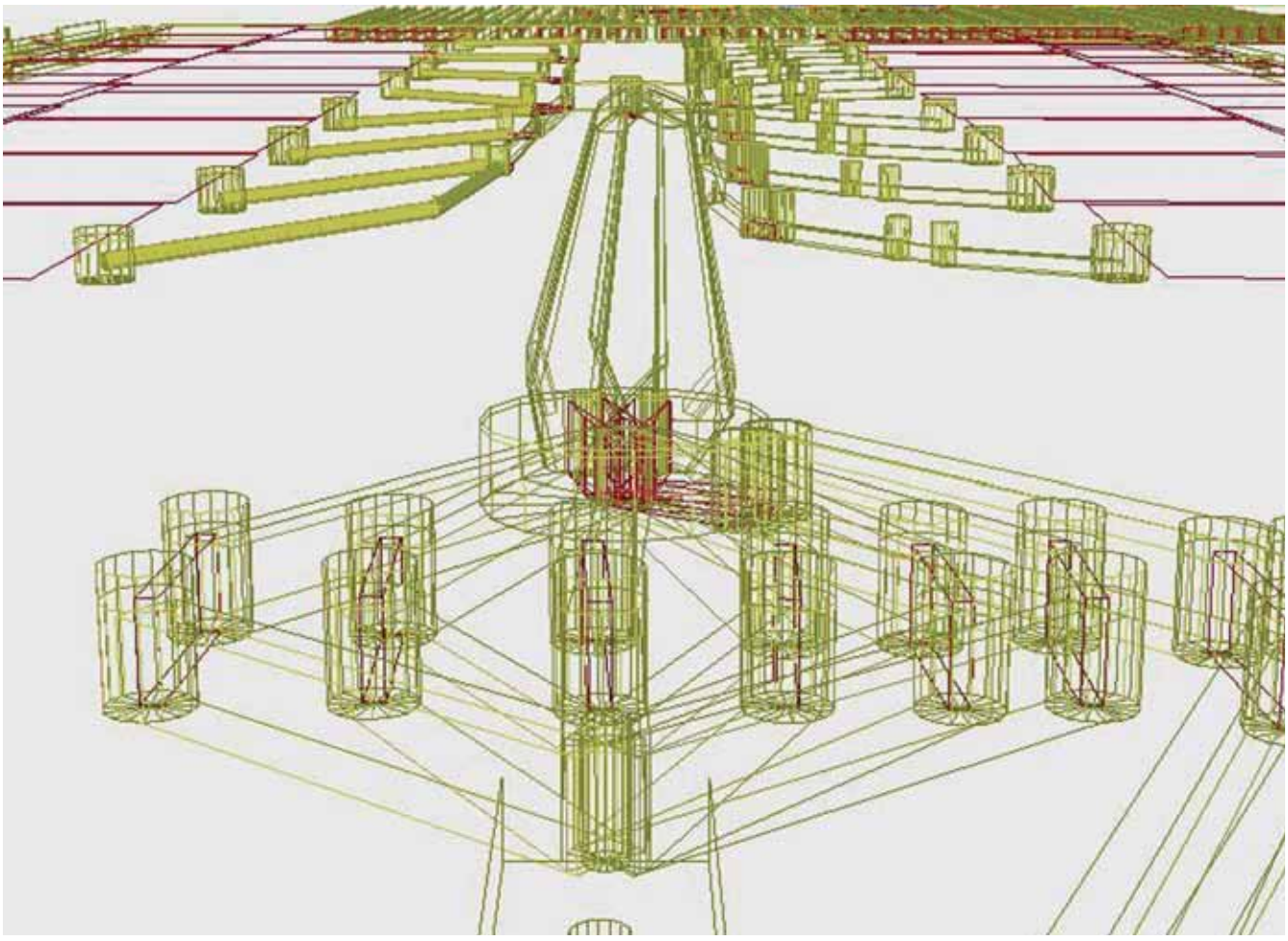
**The calculation of hydraulic head losses through sewage and water treatment works has traditionally been a laborious exercise, often involving endless hand calculations and assisted only by static computer models providing a "snapshot" of the hydraulic gradient through the works for particular flow conditions. Even computer models to simulate the biological processes tend to be "black Box" in nature, based upon empirical methods of calculation. That said, most sewage treatment works in the UK do perform as expected by their designs, but the opportunity for refinement of hydraulic performance other than manually "tweaking" control valves in the works has until recently remained a challenge. As part of Thames Water's review of hydraulic capacity of its strategic sewage treatment works, Hyder Consulting, one of Thames Water's framework consultants, was asked to look at applying the dynamic modelling software used for the assessment of sewerage networks to assessing the hydraulic capacity of three of its STWs.**



3D graphic wire diagram *courtesy Hyder Consulting*

**Main purpose**

The main purpose if this project was to enable Works operators and planners understand why certain flow splits were not equal, understand the real 'freeboard' through the works and to test the impact of plant outages. In conjunction with modifications to the treatment processing, these would be key factors in increasing flow capacity at each Works by as much as 29%, whilst minimising the need to physically extend the works to meet this demand due to limited land availability at each site as well as to achieve best value.

There are a number of advantages of building a computer hydraulic model as opposed to undertaking manual calculations. Once built, the model can be quickly run for a range of fixed or time varying in-flows below and above the design flow to full treatment (FFT) values, and the results analysed to assess water levels throughout the works. On large or hydraulically complex STWs, a hydraulic model provides an essential tool to assess the effects of hydraulic boundary conditions, the impacts of variations in weir or penstock settings, the impacts of plant outage, and for analysing the impact of the proposed sewage treatment works upgrade schemes.

Widely used throughout the world as a hydraulic modelling tool

Hydrodynamic modelling: PST *courtesy Hyder Consulting*

*Infoworks CS*, produced by Wallingford Software,was selected as it has become 'industry standard' software in the UK and is also used by Thames Water for modelling its sewerage networks. The finished STW model can also be appended to an Infoworks sewer network model and this can create a powerful tool when assessing hydraulic interactions between the sewage treatment works and the sewer network.

Although the potential benefits of computer hydraulic models are clear, there are conversely a number of potential disadvantages when departing from manual calculations. Because hydraulic calculations are coded into the software, it is possible to build and analyse a sewage treatment works model without understanding the hydraulic theory behind it. There is also a requirement on the modeller to suitably represent a tank or ancillary within the model.

Consequently there is a risk that the model will give 'the wrong answers' if parts of the model are not suitably represented or any limitations within the software, or hydraulic formulae are 'exceeded. Because of this, Hyder deployed both its sewer networks modellers familiar with Infoworks CS and both its and Thames Water's sewage treatment works specialists to ensure correct application of the software to the STW components.

Sewage Treatment Works are often a complex combination of pipework, tanks and structures and mechanical plant, often featuring a mix of plant ages, additions and modifications, so it is not surprising that the computer models built were quite large and not dissimilar to the sewerage network of a small town. In one case the finished model featured 900 'nodes', 80 pumps, 200 weirs and 300 sluices, as can be seen in the 3D illustration taken from the Infoworks CS Viewer.

Simply applying the default model components usually deployed in sewerage models was not an option and in most cases the model components had to be set individually from observed data and record drawing of the works. For example, an important consideration during hydraulic analysis of the sedimentation tanks was the assessment of water levels within the launder channels relative to the sedimentation tank weir level. The correct representation of the flow distribution over the weir, the launder channel capacity, and outlet controls, were important aspects of the model. Two methods for representing the distribution of flow over the weir into the launder channel, the first, involving breaking the weir up into a symmetrical series of smaller weirs and connecting them from the tank to 'dummy' nodes on the launder channel. The second involved deriving a 'lateral in flow' approach'.

Similar bespoke approaches had to be undertaken for flumes, gates and even individual pipe head losses in order to create a model that properly represented the dynamic operation of the Works.

Calibration of the model involved a mix of flow monitors, observations and interviews with Works operators. Working in the live environment of a major sewage treatment works involves careful planning and strict attention to health and safety as well as not disrupting Works operations.

As a result of this project Thames Water now has a greater understanding of the hydraulic operation and characteristics of three of its strategic sewage treatment works and is able to test the works operations using a dynamic computer model that has the potential to be operated in 'real time' ie to be used as an operational decision tool for the control and future planning of the Works. Thames Water also have a greater understanding of the real hydraulic capacity of three of its strategic Works and can test the impact of plant outages on Works operations.

In conjunction with the treatment process enhancements, the future extensions at these works can now be developed using the models and physical works significantly reduced to maximising investment value and minimise land take around each site. ■

**Note:***Alistair Moseley, is Technical Director for Water Environment and Mike Wood, Principal Modelling Engineer, both with Hyder Consulting.*