

# Broadland Flood Alleviation Project

## Protecting



## Broadland

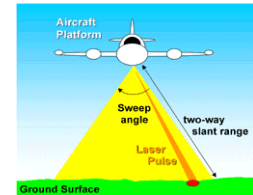
### The Broadland Hydraulic Model : Development and Calibration

#### Survey:

The hydraulic model is based on a comprehensive aerial and ground survey carried out in 2001. The survey recorded the River, Floodbank and Floodplain levels throughout the Broadland area.



GPS ground based survey

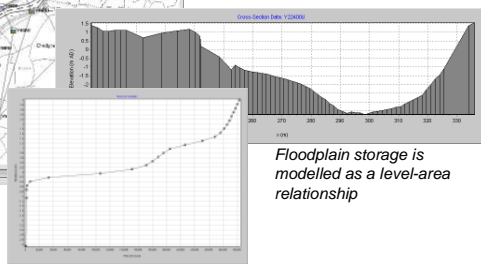


LIDAR survey



The model network

A typical channel section



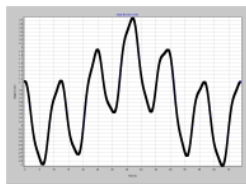
Floodplain storage is modelled as a level-area relationship

#### Model Construction

The model is built using the ISIS software package which is specifically designed to model river levels and flows. Channel sections from the survey are entered to build up the river reaches (there is one section every 200m) these are connected to spills and reservoir units, which allow the model to represent overtopping of the floodbanks and floodplain storage.

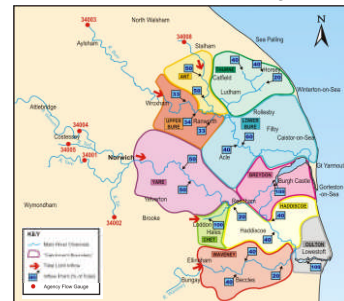
#### Inflows and Boundaries:

A number of inflows are built into the model to represent run-off from rainfall into the Broadland network. These are calculated following FEH (Flood Estimation Handbook) methods - the industry standard for hydrological modelling.



The model boundary at Great Yarmouth

The downstream boundary for the model is the water level at Great Yarmouth which represents flows into and out of the river network. In total there are over 4000 'nodes' (channel sections, spills, reservoirs, inflows and boundaries) in the model.

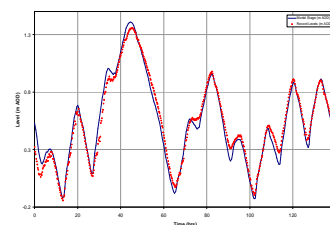


A plot of the sub-catchments and model inflows

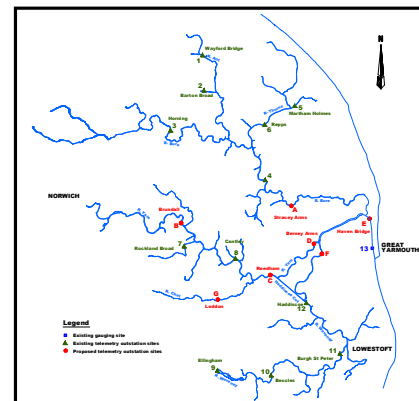
#### Calibration:

To ensure the model accurately represents the reality of water levels and flows in the Broads it has been calibrated to a number of past tidal and fluvial flood events. Data on actual inflows and levels at Yarmouth were entered into the model and the results compared to the levels at a number of gauges throughout the network. The modelled levels correlated very well to the recorded levels and a high degree of confidence is held in the model results.

January 2000 - River Yare : Cantley



A plot of modelled water levels against recorded levels from the Environment Agency gauge at Cantley for one of the calibration events



Locations of Environment Agency gauges used to calibrate the model



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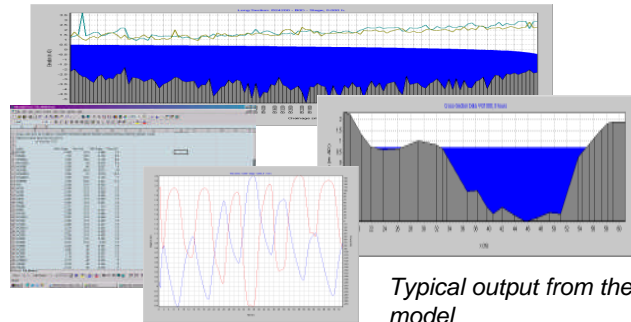


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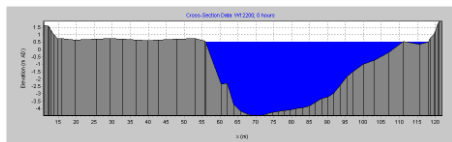
### The Broadland Hydraulic Model :Uses of the Model in the Broadland Project

#### Output from the Model:

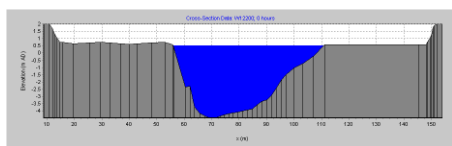
The model outputs can be in the form of tabulated water levels and flows for each point in the system. It is also possible to view the results by individual cross section or to view a long section along the selected reach or river channel. The water levels and flows can also be plotted as a time series. Very detailed analyses can therefore be carried out to assess the impacts of works on levels flows and stored volumes.



Typical output from the model



Channel section before improvements



Channel section showing raised bank crest level and setback

#### The Design Process:

The model is an important tool used to define the flood defence levels and to compare different options for the defence improvement works. The channel sections can be modified in the model, for example crest levels can be raised, banks set back or ronds re-profiled. The model is run for both the 'before' and 'after' cases and the effect of the works on levels and flows is compared. The designer can therefore use the results to help select the best solution for each location.

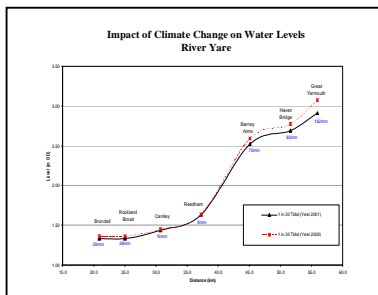
#### Environmental Assessment:

The hydraulic impact of works is of interest to many different stakeholder groups. The hydraulic model allows the project to effectively manage the impact of works on water levels and flows. In particular any water level changes in the vicinity of sites of special environmental interest, or that is close to undefended properties, is an issue which has to be carefully considered. The Broadlands project aims to have no overall impact on water levels. This can be achieved using the model as a tool to aid the detailed design process and to identify existing overtopping areas which should be maintained in the improvement works.



Maintaining existing water levels in the Broads

The results of modelling investigations are reported to interested parties as part of the consultation process.



#### Planning Application:

The model results are reported as part of every planning application as evidence that the project has considered and mitigated against any adverse hydraulic impacts of the works.

#### Further Studies:

The model can be used for further studies into the hydraulics of the Broadland Rivers. In particular the model has been used to consider some of the effects of climate change and sea level rises. The predicted sea level rise due to climate change is 6mm/ year. The model has been used to assess how this rise will influence water levels further upstream throughout Broadland.