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USING LIDAR DATA TO IDENTIFY PROPERTIES AT RISK OF FLOODING
Detailed appraisal of DG5 flooding in Norfolk Street, Boston

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Introduction

The Borough of Boston is situated in fenland in the South East of Anglian Water's Lincoln Division. The Town of Boston is a sea port on the Wash (see Figure 1). The Boston Sewerage System divided into three geographically separate networks by the River Witham and the Maud Foster Drain. The central area, located between the two water courses, is the main area of this study. The main problem was the severe flooding problems in Norfolk Street and Tawney Street. The flooding was known to be a problem since the 1930s. The flooding problems in Boston were to be resolved as part of Anglian Water's AMP3 capital program.

Figure 1: Location of Boston

There were water quality concerns from the storm discharges into the receiving water systems. An 18 month UPM study was commissioned to address these concerns ahead of identifying any flood solutions. The findings of the study revealed that the existing system discharges did not adversely affect the receiving water system. The EA agreed to this provided that there were no further increases to discharges into the river. Ultimately, this impacted the available options to resolve the flooding problems. The available options were more expensive than originally envisaged by Anglian Water.

It was now important to correctly identify the number of properties that were at risk of internal and external flooding. The DG5 register indicated 28 properties at risk of internal flooding but there was a large degree of uncertainty surrounding this figure. This was important to justify the large cost resolving the flooding problems in Norfolk and Tawney Street.

This paper presents the initial investigations into a detailed assessment of the properties at risk of flooding. Current best-practice methods were employed leading ultimately to the state-of-the-art use of LIDAR data in a Digital Terrain Model.

Initial Investigations

As it was important to identify all properties at risk and ensure that they were protected by the scheme, it was decided that more survey data was needed than was available from the sewer records alone. This consisted of:

- Traditional level survey of roads, thresholds and airbricks
- LIDAR data to fill in the gaps and extend the range

Thresholds are an obvious trigger for internal flooding, but so are airbricks – many houses have suspended timber floors, and foul flooding below these can lead to smells and rotting. However, it may not be noticed or reported by residents at the time, or they may not make the connection between such problems when they become apparent and rain which may have fallen some time earlier. Airbricks are, of course, meant to ventilate the space below the floor and prevent damp, but they can also allow flood water to enter and cause the problem.

Norfolk Street is a low point in a flat landscape. An abandoned culverted watercourse runs under and along it, and once formed part of a sewer drain with a tide flap which discharged at low tide to the nearby river Witham. When modern sewerage was introduced from the 1930's on, the system remained combined, leading to the current problems. Only odd areas of separate sewerage occur, including a small section within the Norfolk Street catchment which is served by a surface water pumping station. This also takes spills from a CSO in Norfolk Street, which has recently been fitted with screens to alleviate aesthetic pollution.

It was hoped that the overland flow features included in release 6 of InfoWorks would make this task easier. Figure 2 illustrates the features generated for Norfolk Street. In practice, it suffers from a number of limitations:

- It is limited in its application and user-friendliness
- It doesn't can't take off channel dimensions
- It does not increase the ability to visualise actual flooding

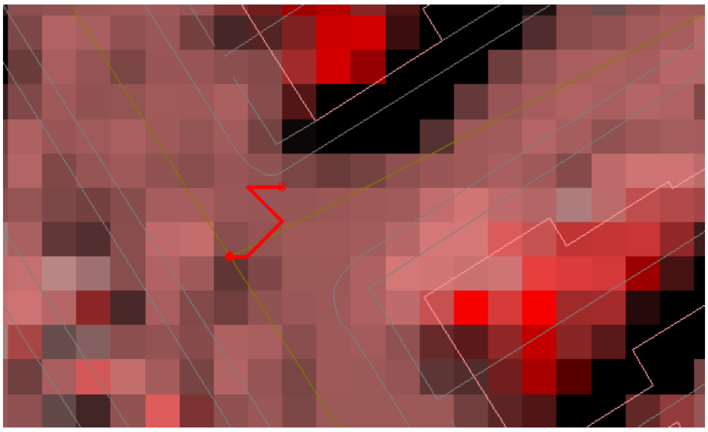

Figure 2: InfoWorks Overland Flow Features

In this case, it was the flatness of the area that defeated the flow routing procedure. This would be far less likely to happen in a steeper area.

InfoWorks uses flood cones to determine flood depth. Usually, this is not a critical factor, but in this case, as the water effectively ponds in the area, it was important to get the depth right to predict which properties would be affected. The LIDAR data was very useful in improving the accuracy of the flood cones, enabling sensible values of the Floodable Area and depths Flood 1 and Flood 2 to be determined – by the simple manual means of tracing contours in MapInfo. This would be very tedious and inefficient over a large area, but was acceptable for the small number of nodes concerned here.

To improve the modelling of flooding, a number of dummy nodes were added to represent gullies, and the nodes were linked by dummy channels to represent the roads. The LIDAR data was also useful in determining exactly where these should run.

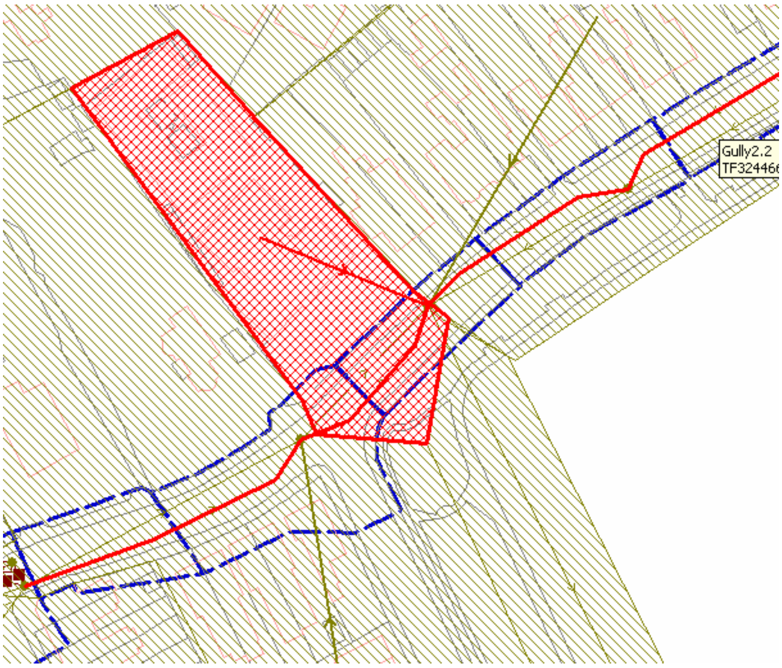

Figure 3: The difference between subcatchments and floodable areas (blue polygons), with dummy channels highlighted

Originally, the verified model gave a fairly inaccurate picture of flooding:

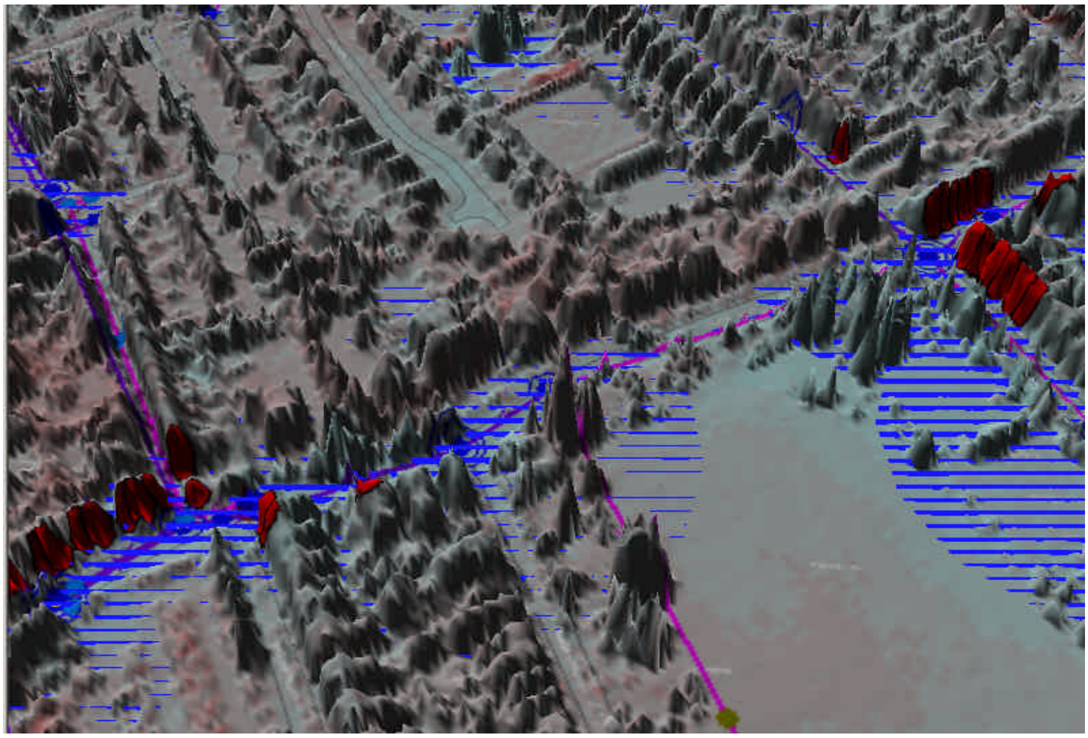

Figure 4: Using unfiltered LIDAR data as a background

With the changes, the flooding corresponds much more closely to what is actually experienced on site. The depths of flooding are also more accurately represented. These improvements are illustrated in the Figures below.

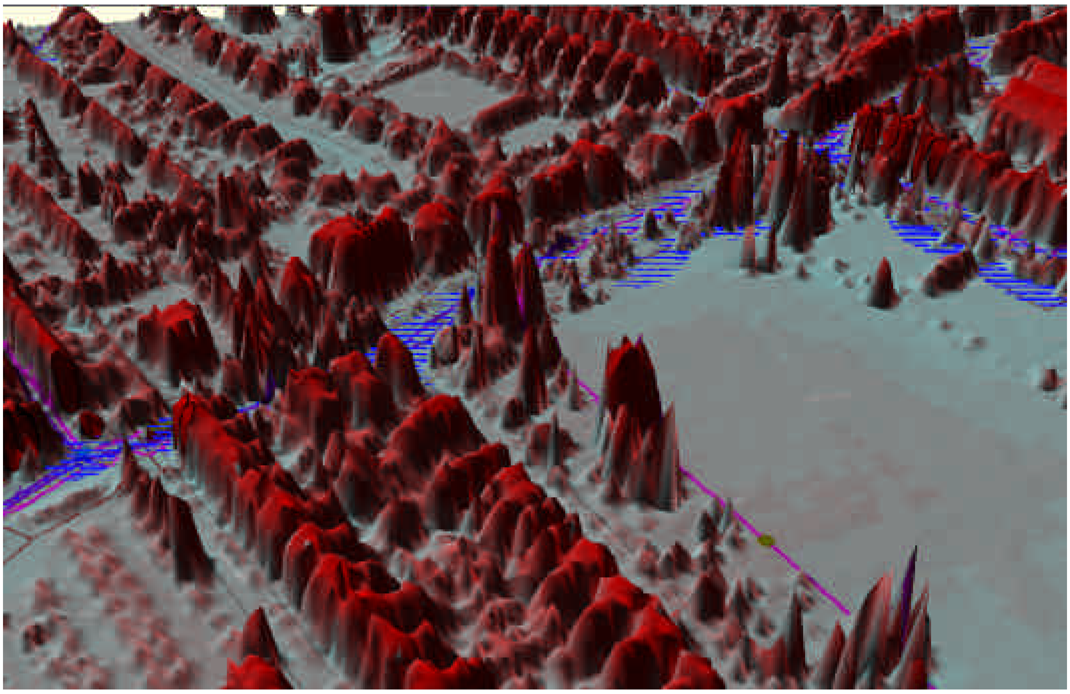

Figure 5: Improved Flooding Prediction

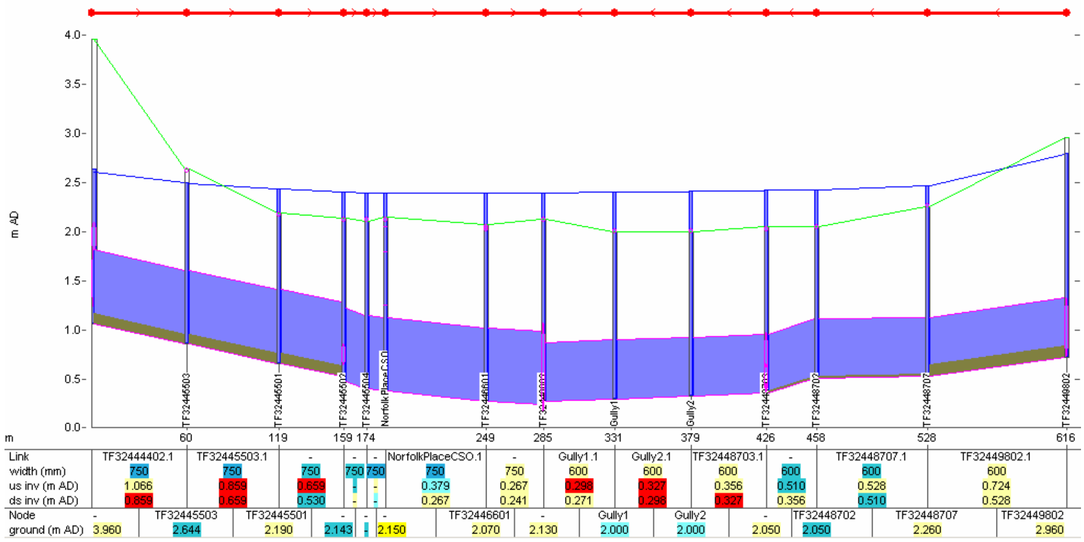

Figure 6: Improved Flood Depth Prediction

However, on its own this wasn't enough to identify individual properties. The final step was to draw flooding contours for each return period (5, 10, 20 and 30 years) based on this information in MapInfo, and use these to identify the properties affected in each case. This allowed properties at risk of internal and external flooding at different return periods to be identified, and coded simply on a plan in the final report, an extract of which is show in Figure 7 below.

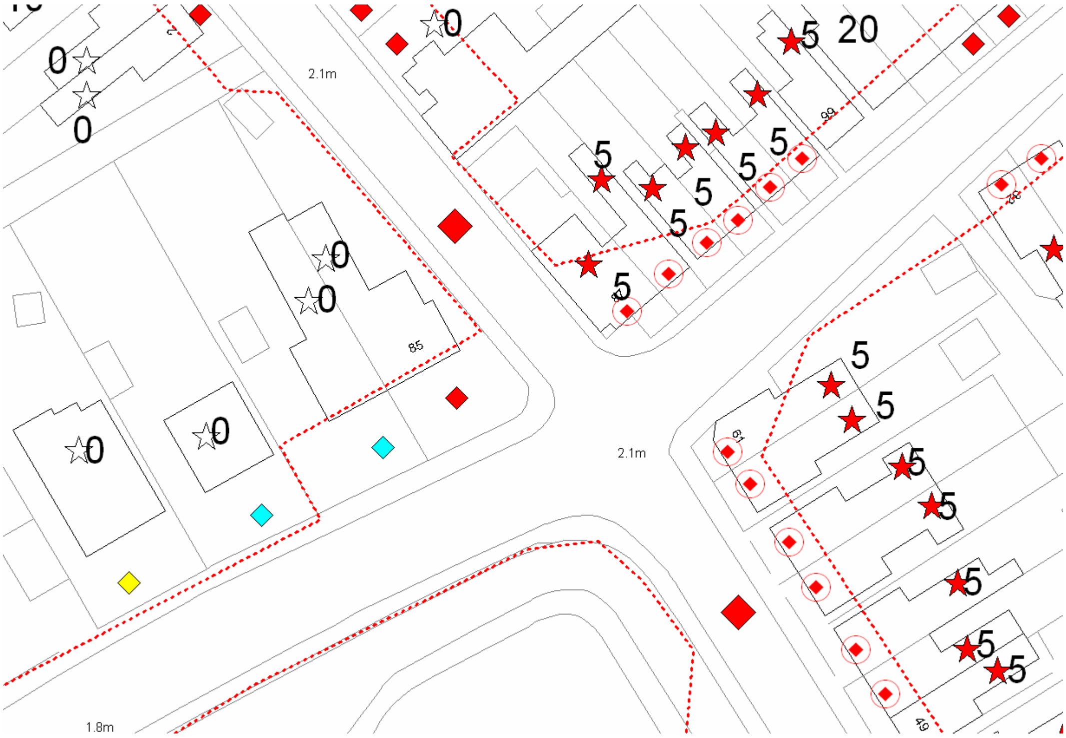

Figure 7: Flooding Properties

Initially, 28 DG5 properties were listed on AWS's database. The updated benefits were:

- internal - 44 DG5s, 6 D10s, 7 D20s
- external - 29 2 in 10 years including approximately 450m of highway in 7 streets and 2 open spaces, and 8 each of 1 in 10 and 1 in 20 years.

The final scheme was shown to provide 30-year protection to all properties against internal flooding, and also to the highways and other external areas. Theoretically, it would be possible to fine-tune the design to provide a lower standard of external protection, and to demonstrate that in the same way. That approach was not taken here.

A BETTER WAY

InfoWorks CS doesn't really use the DTM (Digital Terrain Model) to the full. The method used to overcome this was a time-consuming and convoluted way of getting there. It would be so much easier if InfoWorks CS made better use of DTM data, in the way the RS does. An example of DTM is illustrated in Figure 8.

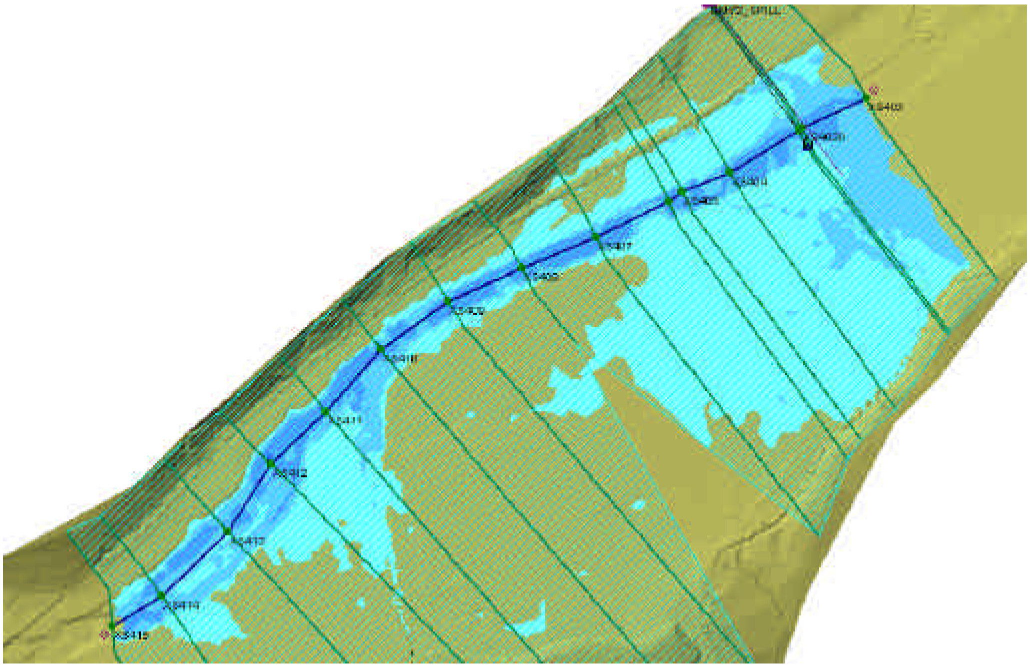

Figure 8: Example of InfoWorks RS DTM

Here we see flood extents directly mapped from the DTM. It should be possible to apply the same technique in CS. RS models tend to be a single channel, whereas CS models are, of course, heavily branched, which could complicate the issue,.

Wallingford Software seem receptive, so we can but hope. In the meantime, there is a way that only involves a) waiting for release 7 and b) paying for an RS licence if you don't have one already.

It depends on using OpenMI, which allows models to exchange data on a timestep level. This in turn depends on installing .net components on your PC, so those of us lucky enough to have large corporate IT services only have to overcome their entirely sensible resistance as well! Once installed, you then create a small dummy river section in the area of interest, and link the CS nodes to RS cross-sections, and you get RS flood extents. Unfortunately, it wasn't possible to get to this stage in time for this paper.

CONCLUSIONS

The use of LIDAR has proven to be extremely useful in correctly assessing the number of properties at risk of internal flooding. This has ultimately provided the justification for the resolution of the flooding problems along Norfolk Street to be resolved. There is also a high degree of confidence in the hydraulic predictions of the hydraulic model.

LIDAR data (or a ground model from some other source) can be used to help identify properties at risk of flooding far better than traditional flood cones. InfoWorks RS style modelling of flooding could very usefully be extended to CS to help improve the process.