PREDICTING FLOODING USING HYDRAULIC MODELS

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1. INTRODUCTION

When a verified hydraulic model predicts flooding careful assessment is required to determine its effect. Small flood volumes (say < 25 m^3) usually pond on roads or open areas without causing problems; in which case they may be ignored. Larger volumes have to be considered in more detail.

Every hydraulic model is to some extent a simplification since each node represents a number of points (e.g. manholes or gullies) from which the flooding could emerge. Floodwater may flow overland from a point of exit to a location where damage results. This will be entirely dependent on local conditions. In order to assess the effect of predicted flooding, it is necessary to clearly understand:

- where excess flows will exit from the system
- the depth, extent and location of any surface ponding
- the overland flow route that flows will take from the point of exit to the location of ponding and/or re-entry into a sewer system or watercourse

Some software now includes a facility to model the overland flood route. Further information on the use of overland flood routing models is given in WaPUG Usernote 37.

2. CRITICAL DURATION

When the Wallingford Procedure design storms are being used, then a range of different storm durations should be run to determine the duration of storm that produces the worst flooding at a given location. This duration will normally be greater than or equal to the time of concentration to the point where the flow that causes the damage exits from the system.

3. INFORMATION REQUIREMENTS

Ideally a detailed terrain model of the catchment including all points of entry to the sewer system, all effective barriers such as kerbs, walls as well as changes in ground level would be used. However, the cost of data collection at the required level of detail is unlikely to justify such an approach.

Current practice is to examine the data for each sewer length from large scale (usually 1:1250 scale) maps, and, where necessary, to inspect the site and to determine the likely point of exit from the system and the route of flow. In some circumstances it may also be possible to visit the site during extreme rainfall to observe the overland flow processes.

4. ESTABLISHING THE POINT OF EXIT

A brief assessment of the lowest point in the system should have been carried out during model building. However, if flooding is predicted, a more detailed study of the local area is advisable to determine more precisely the point of exit connected to the lowest ground point. Particular care should be taken with a basement that drains to the sewer system since, if the ground level at this point is not similar to the ground level in the model it will be necessary to amend and re-run the model.

5. OVERLAND ROUTE OF FLOODWATER

Once the point of exit is known it is necessary to determine whether the floodwater:

- ponds on the surface and return to the system through the same point later
- flows overland to a point where it either ponds or immediately enters the same or another system or a watercourse

The following procedure is recommended:

1. Examine the slope of the ground, the presence of barriers such as walls, kerbs etc. that may obstruct the flow, causing surface ponding, or divert the flow, to determine the route of the flow. Some estimate of the rate of flow will have to be made to estimate whether such barriers would be overtopped. The rate of flow can be estimated from the volume of flooding and an estimate of the duration of the flows exiting the system. This will usually be brief.

2. Examine the data for the existence of neighbouring sewer systems, watercourses, adjacent pervious areas or adjacent properties, to determine whether the flooding will re-enter another drainage system. For example, flooding from a partially separate system may discharge into a storm sewer system without causing any discernible damage. It may be necessary to carry out further modelling to determine whether there is sufficient capacity to allow it to enter the other system.

3. Where flow is contained within the channel of a road it will be necessary to consider whether the flows may be perceived as flooding or just as flow that has been unable to enter the sewer system and would be acceptable at that location. The route of the flow from the point of exit from the system will, however, have to be considered.

4. Examine the data to evaluate what area will be affected by surface flooding. The depth of flooding should be evaluated from the predictions of volume and area.

5. Determine where flooding will appear on the surface and, if it does not affect a property, carry out a depth calculation to determine whether the flooding will be perceived as a deep puddle that is acceptable in extremes of wet weather or whether it will be regarded as surface flooding.

Methods of calculating gully capacity and depths of flow in channels are given in BS EN 752:2008 (Ref 1).

6. VERIFICATION

Where possible, the location and/or frequency of flooding should be verified by reference to flooding reports.

7. NEW ESTATE DESIGNS

Sewers for Adoption (Ref 2) requires developers to consider the potential route of sewer flooding from very extreme rainfall, that is, outside the design limits, when designing new developments. In some cases the effects of flooding may be mitigated by the careful positioning of buildings in relation to the topography of the site, and by the design of landscaping to include raised banks where necessary to divert flows away from buildings.

In some countries this philosophy has been extended to allow runoff from extreme storms to take a different, planned route above-ground either to a different or the same point of disposal. These systems are sometimes referred to as major/minor systems.

8. ACCURACY

The accuracy of predictions of the security of flooding from a storm depends on the accuracy of the model and of the level data used. Predictions of the accuracy of frequency of occurrence derived from use of the Wallingford Procedure design storms should include the possibility that alternative storm profiles and catchment conditions may occasionally produce more severe conditions (Ref 2). If accuracy is critical then an approach using rainfall time series with historic or synthetic rainfall data should be considered

9. REFERENCES

1. British Standards Institution. BS EN 752:2008 Drain and sewer systems outside buildings, 2008.

2. Water Services Association. Sewers for Adoption. 6th Edition 2006.

AMENDMENTS

Ver	Description	Date
1.	First Published	February 1996
2.	Revision	March 2009