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SEWER FLOODING RISK

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1. INTRODUCTION

WRc has recently carried out some research to investigate certain issues related to sewer flooding. This work was funded by the Foundation for Water Research and is reported in full in Foundation Report FR0309. The work addressed three issues.

- Concern that the Wallingford Procedure Design Storms may be under-estimating the frequency of flooding.
- Determining the effect of flood volumes predicted by a hydraulic model.
- Determining the return frequency of a reported flood.

2. ACCURACY OF CURRENT DESIGN STORMS

To investigate this three verified models were used to compare flood predictions using historic rainfall series from rainfall records between 15 and 22 years duration, with predictions using design storms. Attempts to compare these predictions with reporting flooding records were inconclusive.

The results of the comparisons between historic rainfall series and design storms showed significant differences in the predicted flood frequencies. These do not appear to follow any fixed relationship, the differences varying between and within the different catchments used. Of particular note, was the finding that at a small but significant number of sites within each catchment the design storms predicted a substantially lower return frequency of flooding than the historic time series. There were generally a similar number of sites where the effect was reversed. We must therefore treat the predictions of design storms with some caution and, in the longer term look to alternative methods of design and analysis.

The use of Time Series in place of design storms is not currently practical due to a lack of local rainfall data and the short duration of those series available. In the longer term it may be possible to develop the stochastic rainfall generator to produce suitable series.

3. PREDICTING THE ROUTE OF FLOODING

One of the reasons that models sometimes appear to over-predict flooding is that the predicted volume of flow on the surface may not be perceived as flooding. This may be because:

- they appear as large puddles
- they flow along the road as large flows in the channel
- they flow into another system
- they flow into a watercourse
- they pond on wasteland or agricultural land and soak into the ground.

One further factor is that in extreme events, the predicted flood volumes may be flows which have been unable to enter the system, and which are consequently less polluting and contain no sewage debris.

In considering the effects of predicted flooding therefore, we must consider four things:

- Where the flooding will emerge from the system (we must ensure that the lowest point of the system is included in the model).

- The route the flooding will take and the likely depth of flow.

- The depth of flow or size of puddles which will occur and whether these will be perceived as flooding.

- The land or property that the flow will encounter on this route e.g. highways, parks, wasteland, farmland or buildings.

In considering the route of flooding we must remember that some quite small obstacles can be quite significant in diverting the flow. Detailed modelling using terrain models are therefore likely to be uneconomic because of the cost of data collection. This makes it difficult to assess precise effects of flooding without visiting the site. Conversely, it also gives us the opportunity to reduce the impact of flooding sometimes at minimal cost. This aspect of design should be given greater consideration by developers as care in designing the layout could significantly reduce the impact of flooding in very extreme events should it occur.

4. ASSESSING THE FREQUENCY OF AN OBSERVED FLOOD

Flooding is dependent not only on the intensity of the rainfall but on a number of factors which relate to the sewer system both upstream and downstream. Accurate predictions on the return frequency cannot therefore be based solely on rainfall measurements even if such measurements are available. Three methods are suggested with decreasing accuracy.

a) Comparison with observed flooding histories.

The ideal method would be to compare the severity of the the flood with a reference series of observed flooding at the same location. The reference series would need to be quite long to give any confidence (at least 2-3 times frequency of the flooding). Long series of flood data are seldom available and where they are available they are usually affected by changes in the catchment or the sewer system. This method is therefore unlikely to be a practical approach.

b) Comparison of predicted flooding history

This is a variant of the method described above and involves constructing a reference series using a sewer hydraulic model, and a detailed consideration of the effect of predicted flooding.

Although much more practical, the results will be affected by the accuracies of the rainfall methods used (see above) and will not take account of any flooding due to transient problems such as blockage. Nevertheless where a verified model is available it is the best practical approach.

c) Assessment of rainfall data

If accurate rainfall data is available at a sufficient resolution (remembering that extreme rainfall events are often quite localised), then the depth of rainfall in a certain duration can be compared to the intensity frequency curve from the Wallingford Procedure for the same duration (see Volume 4 of the Wallingford Procedure). The duration used should be the critical duration for rainfall flooding at that site. If at all possible this should be determined from a model, otherwise where no model exists a rough approximation would be to take a duration equal to twice the time of concentration measured at the free outfall of the catchment. This approximation may however be subject to considerable error.

Comparing the maximum depth occurring during any period equal to the critical duration in the observed rainfall profile with the frequency curve from the Wallingford Procedure for the same duration will give an estimate of return frequency.

5. CONCLUSIONS

a) Current methods for assessing the risk of flooding, used in the design and analysis of sewer systems can under-predict (or over-predict) the risk of flooding in certain instances. These are highly dependent on the location of the predicted flooding.

b) The effect of a predicted flood volume should be considered in some detail by determining the point where the flow will emerge from the system, the route the flood flow will and the types of surfaces that will be affected.

c) Greater consideration should be given to the effect of flooding when designing new developments as minor changes in layout and topography can significantly reduce the effect of any sewer flooding.

d) Predicted flood frequencies should be treated with care as current methods have been shown to be imprecise.

3.1 Determining Risk of Flooding from Sewers

N Orman (WRc)

Question

Dave Walters M W Barber and Company

Does the DG make a distinction between flooding due to heavy rainfall and that due to other things like blockages ?

Answer

Yes. The DG says that flooding due to temporary effects like blockages is to be noted but not included on flood risk assessment.

Peter Sunderland West Dorset District Council

Comments

In small catchments the cut off of flooding below 25m3 is not always good practice and flooding at this level can still cause problems. Also flooding accumulates at low spots and these should always be identified if problems are to be avoided.

John Packman Institute of Hydrology

Comment

Design storm was chosen as an average there will be times when it is under and over.

Martin Osborne Hydraulics Research

Comment

There are proposals to take design storms forward and do further work if funds can be made available.