Cyfoeth Naturiol Cymru
Natural Resources Wales

Guidance note

Flood Risk Management

Modelling blockage and breach scenarios

Reference number: GN43

Document Owner: Flood Risk Analysis Sub-Group

What is this document about?

The performance of structures and defences can significantly affect the speed of inundation of a site, the flow routes, flood extents, depths and velocities, and is something that must be considered as part of a flood consequence assessment. Flood water is likely to carry a significant amount of debris which has the potential to cause blockage at structures. Defences can reduce the frequency of flooding; however, they can be overtopped and potentially fail.

This guidance sets out how Natural Resources Wales (NRW) assesses these two variables; blockage at structures and breaches in defences, through hydraulic modelling.

Who is this document for?

This guidance is aimed at officers in our Flood Risk Analysis teams but may also be a useful reference document for our Development Planning teams and external customers including flood risk consultants.

Contact for queries and feedback

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Version History		
Document Version	Date Published	Summary of Changes
1.0	12-2014	Document published
2.0	02-2015	Updates made and signed off
3.0	09-2020	Document amended to external guidance note
Review Date: April 2021		

To report issues or problems with this guidance contact Guidance Development

Our Approach

Blockage

Within a flood consequence assessment, consideration should be given to the likelihood of flooding caused by blockage and the potential consequences of such blockage. Hydraulic modelling of flood risk should include sensitivity testing to examine the consequences of blockage.

Whilst it is relatively straightforward to assess the impact of obstruction on upstream water levels; it is more difficult to decide on a credible degree of blockage. The likelihood of material accumulating depends on various risk factors including the type and size of structure and nature of the debris. In order to carry out a hydraulic analysis of blockage, it is necessary to make assumptions about the degree of blockage.

The appropriate proportion of blockage is usually a matter for pragmatic judgement, and often relies on local knowledge; there is no definitive guidance, although some guidance for culverts is available, as shown in Table 1.

Table 1 – Current culvert blockage guidance

Guidance document	Blockage proportion
CIRIA Culvert design and operation guide, 2010 (Table 6.4)	20 to 67% depending on catchment, 100% (blinding or blockage) 5%, 15-25%, 80-100% (for sedimentation of culvert barrel)
EA Trash and Security Screen Guide, 2009 (Table 10.2)	30 and 67% of the screen area, 100% blockage of the screen.

To ensure consistency, the standard figures shown in Table 2 should be used for modelling blockage at bridges and culverts where no better information is available. These figures are based on the guidance shown in Table 1 and current working practices. Lower figures are applied at bridges as they are normally less prone to blockage. However, local knowledge and engineering judgement will also be used to apply varying proportions if considered appropriate at a particular location.

Table 2 – Standard blockage proportions

Blockage Scenario	Culvert blockage proportion	Bridge blockage proportion
Low	30%	5%
Medium	67%	25%
High	100%[1]	80%

[1] Note that a 95% blockage is usually adopted over a 100% in the hydraulic model to maintain a minimum opening and ensure the model remains stable.

The design events to be considered as a minimum are the:

- 1% AEP (1 in 100 year) plus climate change
- 0.1% AEP (1 in 1000 year) events

(Note: additional events can be modelled if deemed necessary for a particular location).

For simplicity in hydraulic modelling terms, a blockage is assumed to be in place for the full duration of the flood event. Its effect on flood risk over the whole event should be reported within the flood consequence assessment.

Breach

The likelihood of a breach of defences that provide any degree of protection to a development site must always be assessed and can be significantly influenced by defence type, location, condition, ownership and predicted loading. The presumption will be that once a defence experiences overtopping during a flood event greater than its design standard, it will fail. If it is considered that the failure of a defence is so unlikely it does not need to be assessed, then this must be supported by appropriate evidence. Where the assessment of failure is required, the location and nature of any breach should be agreed with Natural Resources Wales and should generally be located as follows in terms of priority:

- at any known areas of weakness (e.g. low-spots, the interface between soft and hard defences, outfall structure etc)
- the location where the defence is closest to the to the development site

Ultimately any decision on the breach location will need to be guided by local knowledge.

Unless appropriate evidence to the contrary is submitted and agreed, a breach of defences must always be applied if the design event flood level exceeds the crest level or, is within the design freeboard of the scheme. Freeboard is not included within flood defence design to account for climate change over the lifetime of the development. This is usually applied to account for uncertainties in hydrology/modelling and settlement over time. It is also recognised that the condition of flood defence schemes depreciates over time. Therefore, most development proposals that benefit from flood defences will require assessment of an agreed breach scenario.

The traditional fluvial freeboard allowances, as described in the former PPS25 Practice Guide (section 6.43), are:

- 300mm for hard defences (such as concrete flood walls)
- 500mm for soft defences (such as earth embankments)

These figures are used as a guide; however, it is important to consider the sensitivity of design flood levels taking account of model uncertainty and physical processes. For coastal defences, freeboard should also include allowances for wave overtopping.

Breach widths vary depending on the nature of the defence. Table 3 summarises typical breach widths[1]. The figures listed should be used as a starting point (including the

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[1] Extracted from *Operational Instruction 303_09 Flood Risk Management: Strategic Flood Consequence Assessment for Wales,* Environment Agency, 2009.

freeboard allowances above) unless more appropriate site-specific information is available to justify using an alternative value.

Location	Defence type	Breach width (m)
Open coast	Earth bank	200
	Dunes	100
	Hard	50
	Sluice	Sluice width
Estuary / tidal river	Earth bank	50
	Hard	20
Fluvial river	Earth bank	40
	Hard	20

Table 3 – Breach widths by defence type

The duration to be modelled is 3 tide cycles or an appropriate fluvial duration (this is based on an estimation of the time lapse between the initial breach and subsequent repair (even if this is a temporary solution).

The breach can be assumed to be present for the whole event (i.e. is deemed to have occurred prior to the event peak), giving a conservative assumption. Alternatively, breach initiation can be timed to coincide with peak water levels or at the point of overtopping (whichever occurs first). This approach takes into account rapid inundation of areas behind defences. A sudden breach is often an issue for model stability and so defence height may need to be gradually reduced to the base level. The failure mode of a defence will be a function of the defence type.

The design events for breach modelling are as shown in Table 4, relating to A1.14 of TAN 15.

Type of development	Fluvial AEP	Tidal AEP
Emergency Services	1% and 0.1% plus climate change	0.5% and 0.1% plus climate change
All other development	1% plus climate change	0.5% plus climate change

Table 4 – Design events for breach modelling

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