Project	Gloucestershire JCS Level 2 SFRA	**Date**	September 2010
Note	Hydrological & Hydraulic Modelling Methodology – Leckhampton & Shurdington	**Ref**	WBGCTS
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1 Overview

1.1 Introduction

1.1.1 This technical note details the hydrological and hydraulic modelling approach taken for the Level 2 SFRA assessment of the Hatherly Brook and Ham Brook at Leckhampton & Shurdington area.

1.2 Existing Models & Data

1.2.1 The Leckhampton & Shurdington study area has several watercourses flowing through it, the largest being the Hatherly Brook in the Leckhampton area. There is an existing 1D ISIS model for the Hatherly Brook (SFRM model Capita Symonds 2009). The model has its own hydrological analysis, which was assessed as part of this project before being used in the combined Leckhampton & Shurdington model.

1.2.2 The Hatherly Brook model only cover one channel in the study are, this channel was linked to 2D. The other channels in the area were modelled as 2D TUFLOW channels with 1D ESTRY structures.

1.3 Site Visit

1.3.1 A site visit to Leckhampton & Shurdington area was undertaken prior to the commencement of any analysis of the watercourse to obtain a more detailed understanding of structures within the modelled extents and identify possible floodplain flow routes, particular attention was paid to the structures which were to be included in the 2D only sections of the model.

2 Hydrological Analysis

2.1 Introduction

2.1.1 The existing 1D ISIS SFRM model of the Hatherley Brook (Capita Symonds 2007) was provided for use in this study by the Environment Agency. Two of the upstream boundaries for this model (BR01 and BR02 – see Figure 2.1) correspond with the Leckhampton site.

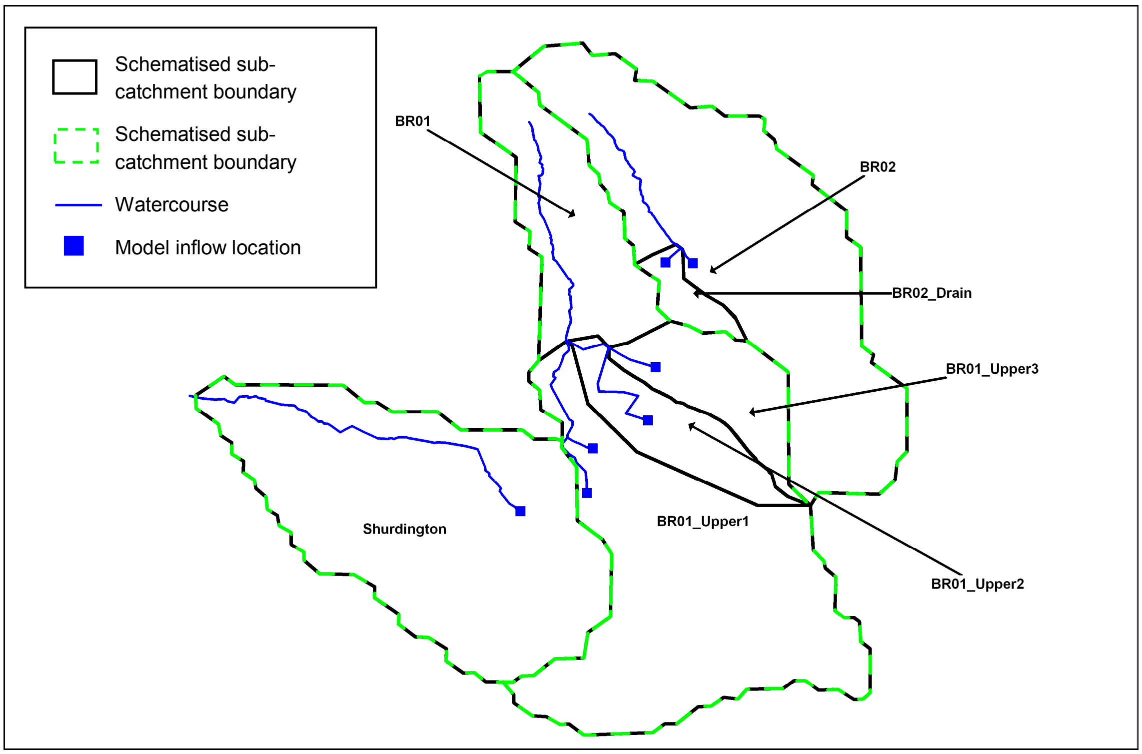

Figure 2.1: Catchment schematisation

2.2 Hydrological appraisal

2.2.1 The flow boundaries in the 2007 SFRM Hatherley Brook model were checked. BR01 was a FEH rainfall-runoff boundary, and BR02 was a flow-time boundary derived using the Modified Rational Method. An error was found in the calculation spreadsheet used to estimate the flows for BR02 such that the flows for this boundary were over-estimated by around 30% in the existing Hatherley Brook model. This was corrected in the derivation of flows in this study. A sensitivity run was also undertaken using the 1% AEP event with flows in BR02 reduced by 30% compared with those in the original model. The results can be seen in Figure 2.2. There was little difference in the modelled outlines with the decrease in flow.

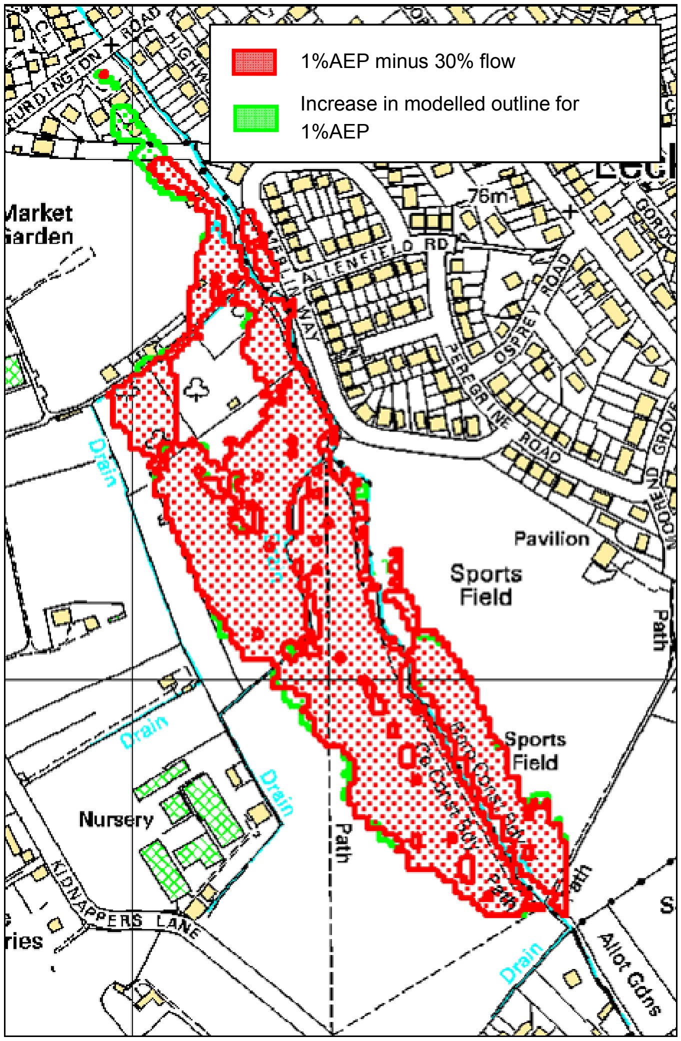

Figure 2.2: Difference in modelled outlines for BR02 with 30% less flow

2.2.2 In addition to flows BR02 and BR01, the Shurdington area falls within a separate catchment, that of the Ham Brook (see Figure 2.1). Given the similarity of the Shurdington and BR01 catchments in terms of topography, geology and land use, flows for the Shurdington catchment were derived in the same way those for the BR01 catchment in the Hatherley Brook model (FEH rainfall-runoff) in order to maintain an approach consistent with previous hydrological studies.

2.2.3 Given that both the Shurdington and Leckhampton catchments are ungauged, there is a degree of uncertainty in the final flows produced. A test on the sensitivity of model outlines to flow was therefore undertaken for the 1% AEP (1 in 100 year) event by increasing and reducing the flow by 20%. The results are shown in Figure 2.3. It can be seen that flood extents are more governed by the topography than flow, and the flood extents are relatively insensitive to flows.

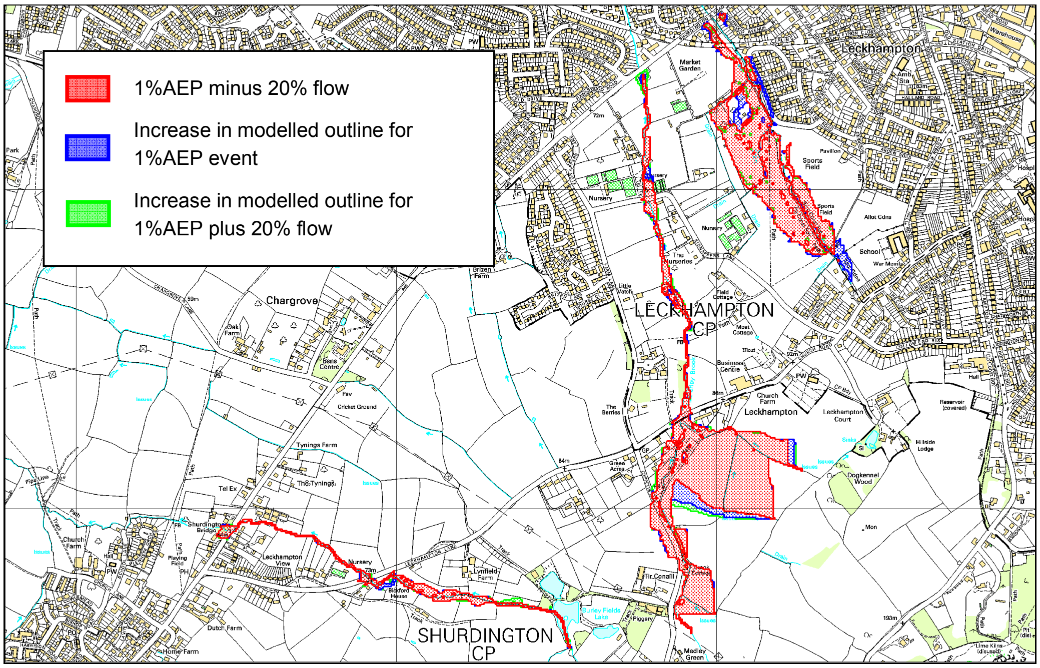

Figure 2.1: Flow sensitivity modelled outlines

2.2.4 Seven upstream model inflow boundaries were required for the hydraulic model. This meant that dividing catchments from the FEH CD ROM using the LiDAR DTM and tools in GIS was required. The resultant sub-catchments (shown in Figure 2.1) were manually verified against OS data and the LiDAR data. BR01 and BR02 inflows were therefore divided between the various upstream model boundaries shown in Figure 2.1 using area-weighting. 'BR01 Upper1' flows were divided equally between the two relevant upstream model boundaries, as interrogation of the LiDAR in this region did not indicate any clear catchment delineation.

2.2.5 Storm duration sensitivity runs were carried out using the 1% AEP event in order to arrive at the critical storm duration for the Leckhampton and Shurdington site. It was found that the critical storm duration, in terms of modelled levels and flood extents through the site, was 5.25 hours, which was therefore adopted for all return periods.

2.3 Conclusions

2.3.1 The final peak flows adopted in the model are as shown in Table 2.1.

Table 2.1: Final peak flows adopted in the model

			Maximum flows in m^3/s			
Boundary location	**Watercourse name**	**Node label**	**5% AEP fluvial**	**1% AEP fluvial**	**1% AEP fluvial with climate change**	**0.1% AEP fluvial**
SO 9369 1831	Ham Brook	Shurdington	1.21	1.90	2.28	3.62
SO 9442 1970	Hatherley Brook	BR02	2.84	4.32	5.18	7.82
SO 9430 1970	Hatherley Brook	BR02 Drain	0.16	0.25	0.30	0.45
SO 9397 1842	Hatherley Brook	BR01 Upper1a	0.61	0.96	1.15	1.83
SO 9399 1866	Hatherley Brook	BR01 Upper1b	0.61	0.96	1.15	1.83
SO 9423 1882	Hatherley Brook	BR01 Upper2	0.35	0.55	0.66	1.05
SO 9426 1912	Hatherley Brook	BR01 Upper3	0.37	0.59	0.71	1.12

3 Hydraulic Modelling

3.1 Hydraulic Modelling

3.1.1 This section outlines the hydraulic modelling approach taken for the Level 2 SFRA assessment of the Hatherly Brook and Ham Brook in the Leckhampton & Shurdington area.

3.2 Model extent

3.2.1 The section of the Hatherly Brook model which has been used in this area extends from Church Road in Leckhampton (SO 94416 19711) to Merestones Road (SO 93666 20776). A section of the Hatherly Brook was also modelled as a 2D channel, this reach extended from its sources (SO 93920 18611, SO 93999 18672, SO 94193 18963, SO 94266 19121) to upstream of Shurdington Road (SO 93769 20349). In the Shurdington area the Ham Brook has been modelled as a 2D channel from (SO 93546 18564) to downstream of Shurdington Bridge (SO 92453 18942). Figure 3.1 below shows the extents of the 1D-2D model covering the study area.

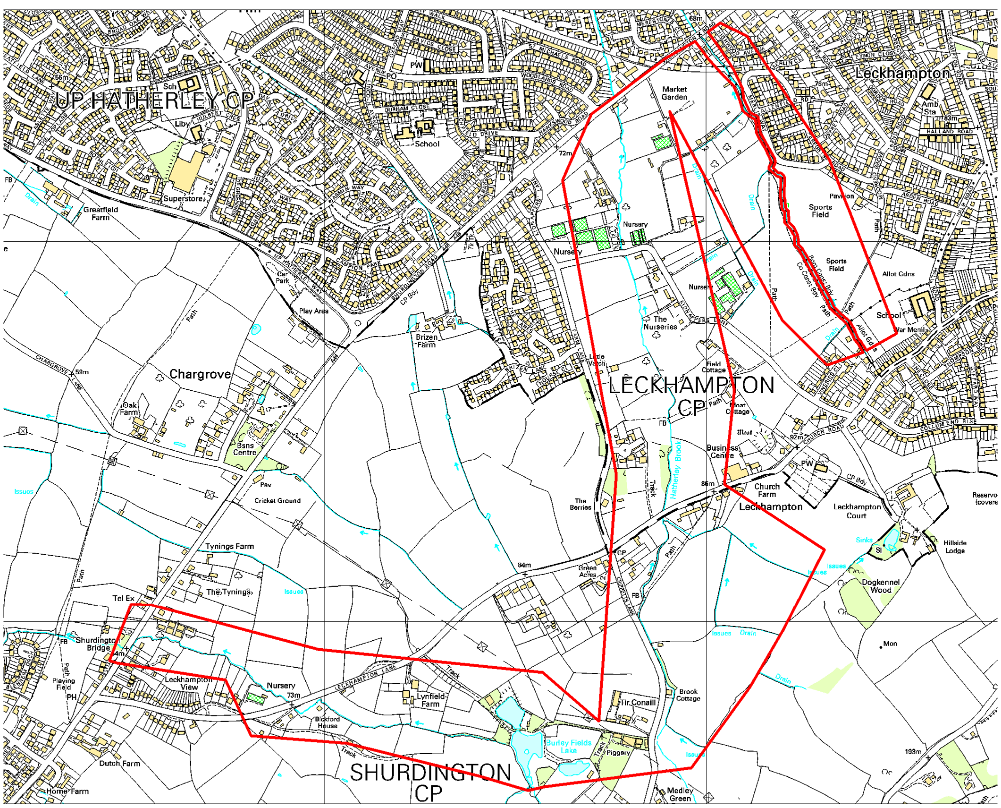

Figure 3.1: Leckhampton & Shurdington model extents

3.3 Methodology

3.3.1 The existing Hatherly Brook model was reviewed and was determined to be suitable for the purposes of this study.

3.3.2 Through the study area the 1D floodplain of the Hatherly Brook was removed and it was coupled with the 2D TUFLOW grid, the downstream extent of the Hatherly Brook model was also removed to improve model run times as it has no effect on the study area. The 2D channels were observed from LiDAR and were reinforced using z-lines to ensure that they are accurately represented in the 2D channel, this method creates idealised trapezoidal channels. Structures in the channels were represented using 1D ESTRY, with dimensions taken from the site visit (see modelling summary table for estimated culvert dimensions).

3.3.3 A 5m resolution was used for the grid size in this model. This allows for accurate representation of the floodplain while keeping model run times and result file sizes manageable.

3.3.4 There are no formal or de-facto defences in the study area.

3.3.5 The in-channel roughness in the 1D model was left as it was in the original models and the 2d channel and floodplain roughness was assigned using polygons extracted from OS Mastermap data and observations made on the site visit.

3.3.6 Inflow boundaries have been located at the upstream extent of each channel, there are no lateral inflows in the model.

3.3.7 The downstream boundary on the Ham Brook has been modelled as a normal slope, based on the LiDAR in the area, while the boundary on the Hatherly Brook is a normal slope boundary far enough downstream that it has no effect on the study area.

3.4 Sensitivity Analysis

3.4.1 Analysis of the models sensitivity to roughness (Manning's 'n'), flow and blockage was carried out. The results of this analysis are summarised below.

Manning's 'n'

3.4.2 Raising the Manning's 'n' values by 20% causes an average increase in stage of 5mm through the study area while decreasing Manning's 'n' by 20% causes an average decrease in stage of 4mm.

Flow

3.4.3 Increasing the flow by 20% causes an average rise in water level of 12mm while decreasing the flow causes an average decrease in water level of 8mm.

Blockage

3.4.4 Blockage analysis was performed at several locations in the study area, all of the structures blocked were blocked by 75%. The blockage analysis was performed at six locations, at Leckhampton Lane (SO 92911 18782) and Shurdington Bridge (SO 92480 18928) on the Ham Brook, and at Leckhampton Lane (SO 93888 19284), Kidnappers Lane (SO 93783 19969) and two blockages on Shurdington Road (SO 93760 20369, SO 93986 20539) on the Hatherly Brook.

3.4.5 Blocking Leckhampton Lane culvert on the Ham Brook causes an increase in stage of 39mm upstream of the culvert. Blocking the Shurdington Bridge on the Ham Brook results in an increase in stage of 19mm upstream of the culvert.

3.4.6 Blocking Leckhampton Lane culvert on the Hatherly Brook causes an increase in stage of 16mm upstream of the culvert. Blocking Kidnappers Lane culvert on the Hatherly Brook causes an increase in stage of 11mm upstream of the culvert. Blocking the Shurdington Road culvert on the west channel of the Hatherly Brook results in an increase in stage of 720mm upstream of the culvert. Blocking the Shurdington Road culvert on the east channel of the Hatherly Brook causes an increase in stage of 97mm upstream of the culvert.

3.5 Assumptions & Limitations

3.5.1 It is assumed that both the Hatherly Brook SFRM model is suitable for the purposes of this study and has been hydraulically calibrated.

3.5.2 It is assumed that the filtered LiDAR used in the study is accurate and has no errors.

3.5.3 Where channel has been modelled as 2D it has been assumed to be a trapezoidal shape.

3.5.4 Structures dimensions in the 2D channel have been defined from observations on the site visit and have not been extensively surveyed.

3.6 Model Confidence

3.6.1 In the absence of a good and reliable calibration data, sensitivity analysis should be used to set the perspective in terms of how models results should be interpreted. As can be seen from the sensitivity analysis, model results are not sensitive to roughness and flows however if the land use and type changes then this should be reanalysed to ensure that this is still valid and that regular channel maintenance is not required.