

<b>Model</b>	Yazor Brook / Widemarsh Brook Hydraulic Model	
<b>Location</b>	Hereford	
<b>Watercourses</b>	Yazor Brook, Widemarsh Brook, Eign Brook and Ayles Brook	
<b>Objectives/Areas of interest</b>		
<p>The model was originally developed for the purpose of Environment Agency flood mapping of the ordinary watercourses (Yazor Brook and Widemarsh / Eign Brook) through Hereford but has since been extended and used to develop a flood mitigation strategy for the Edgar Street Grid area in Hereford. Details of the model development are provided below.</p>		
<b>Model Development</b>		
<p>The various phases of Yazor Brook modelling are detailed in the following table:</p>		
<b>Model Name</b>	<b>Model Extents</b>	<b>Details</b>
Hereford SFRM, Capita Symonds, August 2007	<p>Yazor Brook - 3.9km from Three Elms Road Bridge (NGR SO491414) to River Wye River Wye (NGR SO506395)</p> <p>Widemarsh / Eign Brooks - 4.0km from bifurcation with Yazor Brook (NGR SO498407) to River Wye (NGR SO522392)</p>	<p>Strategic Flood Risk mapping (SFRM) study of the Hereford Critical Ordinary Watercourses (COWs) for Environment Agency Wales. Involved the production of a linked 1-dimension to 2-dimension hydraulic model of the urban area of Hereford. The 2-dimensional element of the model was initially based on information gained from sewer plans and later updated using LIDAR data when this became available in 2006. The 1d model was constructed using channel survey.</p>
ESG Hereford Flood Mitigation Options Appraisal, Capita Symonds, December 2007	<p>Yazor Brook - 9.8km from Bishon Common (NGR SO426435) to River Wye River Wye (NGR SO506395)</p> <p>Widemarsh / Eign Brooks - 4.0km from bifurcation with Yazor Brook (NGR SO498407) to River Wye (NGR SO522392)</p>	<p>Assessment of possible options to reduce flooding within Hereford. A preliminary options review investigated the effects of implementing channel improvements within Hereford town centre. The model was subsequently extended upstream in order to assess upstream mitigation options.</p> <p>The model was extended upstream by approximately 8.1km from Three Elms Bridge to Bishon Common. The downstream boundary remained at the outfall to the River Wye. The 1d model was extended up to the Roman Road using data from the Whitecross High School Flood Risk Assessment model (Halcrow Group Ltd, September 2003). New channel survey was collected to define the channel between Bishon Common and the Roman Road. The 2006 LIDAR coverage was adequate to define the 2D model element. To reduce the simulation time the new model reach was defined in a separate model domain using a 10m grid size (the existing urban domain was modelled using a 5m grid size). This was deemed appropriate as the level of detailed required in the rural upstream reach was low.</p>
Hereford Livestock Market Flood Risk Assessment, Capita Symonds, 2008	<p>Yazor Brook - 9.8km from Bishon Common (NGR SO426435) to River Wye River Wye (NGR SO506395)</p> <p>Widemarsh / Eign Brooks - 4.0km from bifurcation with Yazor Brook (NGR SO498407) to River Wye (NGR SO522392)</p>	<p>The existing hydraulic model was utilised to assess the impact of fluvial flooding at the proposed livestock market site (to the south of the Roman Road). This section of the model was previously defined using the upper reach of the Whitecross High School Flood Risk Assessment model (Halcrow Group Ltd, September 2003) which was created prior to the redevelopment of the Roman Road. Therefore the model representation was improved in the proximity of the site using the Roman Road 'as-built' drawings and additional topographic and channel survey.</p>

Yazor Brook Flood Alleviation Scheme, Planning Submission and FRA, Capita Symonds, July 2009 [model archive # 1]	Yazor Brook - 9.8km from Bishon Common (NGR SO426435) to River Wye River Wye (NGR SO506395)  Widemarsh / Eign Brooks - 4.0km from bifurcation with Yazor Brook (NGR SO498407) to River Wye (NGR SO522392)	This assessment took forward the preferred flood alleviation scheme for planning. Additional hydrological and hydraulic assessments were completed to inform the scheme design and test its impacts with respect to flood risk. The study included a review of the hydrological assessment for the Yazor Brook which resulted in a change to the design hydrology.
ESG Link Road Flood Risk Assessment, Capita Symonds, October 2009 [model archive # 2]	Yazor Brook - 3.9km from Three Elms Road Bridge (NGR SO491414) to River Wye River Wye (NGR SO506395)  Widemarsh / Eign Brooks - 4.0km from bifurcation with Yazor Brook (NGR SO498407) to River Wye (NGR SO522392)	Modelling completed to assess the impact of the proposed Link Road and ESG Blackfriars Urban Village site on flood risk in the area in support of the Link Road planning submission.  Assessment utilised only the downstream domain of the of the full Yazor Brook model, in order to optimise model simulation time. Inflows extracted from the full model were used to define the 'trimmed' model's upstream boundary conditions.
Merton Meadows Flood Risk Assessment, Capita Symonds, April 2013 [model archive # 3&4]	Yazor Brook - 9km from Kenchester (NGR SO435433) to Friars Street (NGR SO526403)  Widemarsh / Eign Brooks - 4.0km from bifurcation with Yazor Brook (NGR SO498407) to River Wye (NGR SO522392)  Ayles Brook - 0.4km from downstream of the disused railway line (NGR SO509410) to confluence with Widemarsh Brook through pipe outfall underneath Widemarsh Bridge (SO511408).	Hydraulic modelling of the Yazor Brook through Hereford was completed as part of the Flood Risk Assessment (FRA) for the proposed redevelopment of the Merton Meadows car park in Hereford.  For this assessment, the upstream extent of the Yazor Brook was trimmed at Kenchester and the downstream extent trimmed at Friars Street a (short distance downstream from the Bulmers Factory). The extent was reduced primarily to allow simulation of the model using a limited node license.
ESG Drainage Strategy, Capita Property and Infrastructure, July 2014 [model archive # 5]	As above	Hydraulic modelling of the final ESG development scenario to assess the impact of ground level changes required for the drainage strategy.
Jewsons (Canal Road) Culvert Upgrade Assessment, WSP   PB, May 2015 [model archive # 6]	As above	Modelling and assessment to establish the necessity of the Jewsons culvert upgrade taking place alongside the construction of the Link Road. Changes were made to the Link Road scenario (T002) to reflect the latest understanding of the proposals, principally that the channel diversion would take place at the same time hence no temporary Link Road culvert as assumed in earlier iterations. Also included sensitivity scenarios
Fire Station Flood Risk Assessment (FRA), WSP   PB, July 2015 [model archive # 6]	As above	No model changes, just modelling of additional scenarios with the changes from the Jewsons assessment.

Widemarsh Brook Channel Design, WSP   PB, 2015 - 2016 [model archive # 7]	As above	Hydraulic assessment to inform the design of the Widemarsh channel diversion. Details of proposed channel diversion, attenuation basin, Link Road and Jewsons culvert updated to reflect current design proposals (channel and basin) and as-built (Link Road and Jewsons culverts). Also included some wider model updates following a review and a range of sensitivity analyses.
ESG Flood Mitigation WSP   PB, 2016 - 2017 [model archive # 8]	As above	Hydraulic assessment to determine the potential for mitigation for the Edgar Street Grid (ESG) development proposals in Central Hereford. Onsite and offsite mitigation options were explored with the goal of providing a more robust mitigation to facilitate development. Model naming convention was revised and the model updated with new survey [Hereford ESG Mitigation Supplementary Topo and Channel Survey Feb 2017 (survey archive # 13)] in several locations, better representation of walls, updated mastermap layers for material roughness, allowance for potential groundwater ingress to channel, topographic amendments and a number of other minor adjustments and corrections. <b>NB: As of February 2018 the assessment of future development proposals and mitigation is ongoing.</b>
Development of "Present Day" scenario for 3rd party issue WSP 2018 [model archive # 9]	As above	Creation of a new scenario to represent the "Present Day" and to reflect recent construction work in and around the ESG site, related to the Link Road construction. The model update includes: the new Jewsons / Canal Road culvert; the Hereford City Link Road (including new brook culvert); and the channel diversion between Widemarsh Street and Canal Road. As of January 2018 the Link Road, Link Road culvert and Jewsons culvert have been constructed however the channel diversion and Link Road attenuation pond have not yet been constructed with the channel following a temporary diversion through this reach. The permanent channel diversion and attenuation pond construction is expected to take place shortly. The model representation is based on draft design drawings for the channel diversion.

### Survey / Topographic Data

Title	Type	Notes
Whitecross High School Flood Risk Assessment, Halcrow Group Ltd, September 2003 [survey archive # 6]	ISIS 1D model and Channel Survey	Preliminary Flood Risk Assessment to support Outline Planning application for the development of Whitecross High School, Three Elms Road, Hereford. Model extends from upstream of the Roman Road (NGR 347700, 242200) to the Three Elms Gauging Station (NGR 349200, 241500). Data used to extend the original SFRM model up to the Roman Road.
Total Surveys, November - December 2005 [model archive # 1]	Channel Survey	Cross-sections provided on Yazor Brook, Widemarsh / Eign Brook within Hereford city centre, from Three Elms Road to the outfalls with the River Wye. Sections used to construct 1D model domain in the original SFRM model.
LiDAR data, flown 2006	LiDAR Digital Terrain Model	1m resolution within Hereford and 2m resolution upstream of Hereford. Complete coverage throughout model reach. Data used to improve the digital terrain model in the SFRM model.

Wye Lugg Confluence Model v3.1, Atkins, 2008	ISIS 1D model	ISIS model of the River Wye and River Lugg created originally for the Hereford Flood Alleviation Project and later used for flood risk mapping of the Wye and Lugg confluence. Model output used to define the downstream boundary conditions for the Yazor Brook and Eign Brook.
Total Surveys, March 2007 [model archive # 2]	Channel and Topographical Survey	Cross-sections provided on Yazor Brook from upstream of the sewage works (NGR 347150, 243080) down to Pinston House (NGR 347890, 242370). Spot levels taken through at Bulmers factory and hospital site. Data used to extend the 1D model domain and improve the 2D model DTM.
Total Surveys, June - July 2007 [model archive # 3]	Channel Survey	Cross-sections provided on Yazor Brook from Bishon Common (NGR 342680, 243520) to Stretton Court Farm (NGR 347030, 243060). Data used to extend the 1D model domain.
Healer Surveys, July 2007 (correction submitted May 2010) [model archive # 7]	Topographical Survey	Topographical survey including: Old Cattle Market site, Edgar Street, Black Friars Road, Widemarsh Street, Police Training Fields and land bordering the railway. Data used to check the accuracy of the LIDAR data.
Total Surveys, July & December 2008 [model archive # 4]	Channel and Topographical Survey	Further detail provided around Credenhill, from upstream of Station Road (NGR 344480, 242950) to downstream of Credenhill Community Centre (NGR 344600, 242900). Detailed topographical survey collected along the proposed flood alleviation scheme pipe route, including bank and floodplain survey adjacent to the Yazor Brook.
Livestock Market Survey, March 2007 [model archive # 5]	Topographical Survey	Topographical survey of the new Livestock Market_site (pre-construction)
A4103 Roman Road 'As Built Drawings'	CAD Drawings	'As Built' drawings of the Roman Road, indicating road levels, drainage paths and culvert / pipe sizes. Data used to improve the 1D and 2D model representation in the vicinity of the Roman Road.
Hereford ESG Topographical and Sewer Asset Survey, July / November 2009 [model archive # 8]	Topographical, threshold level and sewer Survey	Finalised April 2010.  Topographical survey of remaining ESG development area not included in Healer Surveys July 2007 survey.  Includes sewer and threshold level survey. Data used to check the accuracy of the LIDAR data.
Divers Survey, 2011 [model archive # 11]	Culvert survey	Jewsons culvert survey including photos from divers.  This was used in particular to justify the culvert Colebrook-White roughness values.

Healer Surveys, August 2015	Channel survey	Upstream of Jewsons culvert prior to design works. Sections incorrectly surveyed RHB to LHB. Sections do not provide good definition of channel, hence the information was used in combination with the original channel survey to define the channel through this reach
ESG TopoChannelSurvey Aug2015 [model archive # 12]	Topo and Channel survey	
Hereford ESG Mitigation Supplementary Topo and Channel Survey Feb 2017 [model archive # 13]	Topo and Channel survey	Survey taken as part of the ESG Mitigation project to update and check the model in key areas of interest. Topo survey was primarily to update the walls around Edgar St. Survey Sections 01, 02, 11, 14, & 15 were checked but deemed a good match with previous sections and therefore not updated. Section 13 represents a channel constriction but was deemed larger than the upstream culvert and not subject to out of bank flow and so was not incorporated due concerns over section spacing. Section 10 was checked to be representative of the reach and shifted downstream 10m in the model to maintain consistent section spacing. Section 06 & 07 were not incorporated for the AA (baseline) model scenario as channel work is known to have been carried out so the survey is not representative of this scenario.

### Supporting Data

Title	Type	Notes
1. Yazor Brook FAS (Credenhill)	As Built (Construction) drawings for Credenhill	Model was updated to reflect as-built information at Credenhill. No gauge data is yet available to verify the model
2. Yazor Brook FAS (Outfall)	Design drawings	Floodplain has altered since Wye bank collapse. Ongoing review of outfall options may change outfall arrangement
3. Link Road ground model Aug 2015	Proposed Link Road ground model	NB: A later version has been received (below). A brief check showing no significant changes but the new version has not been used in the model. Ground model does not represent current channel and pond proposals.
4. Link Road ground model Sep 2015 (received Oct 16)	Proposed Link Road ground model	NB: This has not been used in the model. A brief check showing no significant changes but the new version has not been used in the model. Ground model does not represent current channel and pond proposals.



5. Jewsons & Link Road Culvert As Built	Drawings of Jewsons culvert upgrade & Link Road culvert	As-built drawing of the Link Road culvert (refer to 3512983AE-HHC-STR02/01/04 dated 22/02/16) providing info on culvert size/invert levels and revised culvert length. Model was updated to reflect as-built information for the Link Road Culvert; of particular note is the use of the information to justify the model inclusion of a 300mm deep layer of natural material therefore reducing culvert height from 1.8m to 1.5m. As-built drawings for the Jewson culverts were used to update the model with changes being included in model version 3657
6. Widemarsh Brook channel proposals Jun 2016	Proposed channel diversion design	NB: Channel design not finalised. May 2017 draft channel design proposals (see below) used to check and refine the channel representation in the model but model representation based on both sets of data.

<b>Model</b>	Yazor Brook / Widemarsh Brook Hydraulic Model
<b>Location</b>	Hereford
<b>Watercourses</b>	Yazor Brook, Widemarsh Brook, Eign Brook and Ayles Brook

#### Modelling Approach

The Yazor Brook/Widemarsh Brook hydraulic model is a 1D / 2D FMP-TUFLOW model , extending from Kenchester (approximately 1km upstream of Credenhill) to its confluence with the River Wye within Hereford (upstream of Greyfriars Bridge). A bifurcation at Moor Park creates the Widemarsh Brook (also known as Eign Brook downstream of Commercial Road) which passes through Hereford city centre before joining the River Wye near Bartonsham. The Widemarsh / Eign Brook, as well as its tributary the Ayles Brook, are included in the model.

The schematisation of the hydraulic model reflects the catchment flooding mechanisms and key areas of interest. The model consists of two domains with the boundary between the two located along Three Elms Road, to the western side of Hereford. The upstream domain is predominantly rural and has been modelled using a 10m grid size. The downstream domain covers the urban area of Hereford, which is the focus of interest, and therefore has been modelled in more detail using a grid cell size of 5m.

Watercourse	Modelled Length (km)	Upstream	Downstream
Yazor Brook	9.0	343500, 243280	352590, 240250
Widemarsh Brook / Eign Brook	4.0	349760, 240670	350220, 239340
Ayles Brook	0.4	350880, 241040	351120, 240780

#### Model Schematisation

<b>Model Method</b>	1D / 2D
<b>Software</b>	Flood Modeller Pro (version 4.2.0.192) / TUFLOW (build 2016-03-AD)
<b>Run Settings</b>	Unsteady simulation
<b>Channel</b>	1D surveyed sections
<b>Floodplain</b>	LIDAR data supplemented with survey
<b>Other comments</b>	The model consists of 2 model domains; upstream of Three Elms Road a 10m grid is used, while the urban area downstream is represented using a 5m grid.

#### GIS Data

<b>OS Tiles -</b>	10k: SO33NE, SO33SE, SO34SE, SO34NE, SO43NE, SO43NW, SO43SE, SO43SW, SO44NE, SO44NW, SO44SE, SO44SW, SO53NE, SO53NW, SO53SE, SO53SW, SO54NE, SO54SE, SO54SW,
	50k: SO33, SO34, SO43, SO44, SO53, SO54
<b>LIDAR -</b>	Resolution: 1m within Hereford and 2m upstream of Hereford Flown Date : 2006
<b>Mastermap -</b>	Date: circa 2007 (AA Scenario) circa 2017 (BA, EB Scenario)

#### Hydrology/Model inflows

Catchment flows are modelled as a mixture of point and distributed inflows in the model. The flow hydrographs have been derived as follows:

- Yazor Brook (upstream of Hereford): ReFH1 method with the  $T_p$  and  $BF_0$  model parameters improved using data from the Three Elms gauging station, other model parameters are derived from catchment descriptors.
- Ayles Brook: FEH Rainfall Runoff method with model parameters derived from catchment descriptors.
- Sewer inflows (to Yazor and Widemarsh Brooks through Hereford) - Modified Rational method used to estimate peak flows, manual catchment and triangular hydrograph definition.

Two hydrological scenarios have been tested to date. For the catchment wide storm all hydrographs have been derived for a design storm with duration of 25 hours and area of  $44\text{km}^2$ . For the local storm scenario it was assumed that no rainfall occurs over the upper catchment (YA03 and YA04 inflows set to baseflow) and a design storm with duration of 5.5 hours and area  $25\text{km}^2$  occurred over the lower catchment.

The hydrology was last reviewed in 2013.

A series of small 'Dummy' flows have been used within the model to enable it to run for low flows; without these additional flows the model would not function due to model stability issues at low flows.

### **Mannings 'n' Roughness Coefficients**

Manning's n coefficients have been used to represent the roughness of the open channel and floodplain. Estimates of the channel roughness were made following site visits and from channel survey data. The definition of roughness in the 2D domain is based on land use information from OS MasterMap data.

### **Boundary Conditions**

The downstream boundary for the Widemarsh / Eign Brook is the River Wye. This has been modelled using a fixed water level taken from the Wye Lugg Confluence model . A 2 year return period level of 49.21mAOD for the River Wye is applied.

The Yazor Brook outfalls into the River Wye upstream of Grey Friars Bridge. As discussed above the Yazor Brook model extent was trimmed to Friars Street, by which point the watercourse is culverted through to its outfall. A stage-discharge relationship was extracted from the complete model prior to trimming in order to provide accurate boundary conditions.



<b>Model</b>	Yazor Brook / Widemarsh Brook Hydraulic Model
<b>Location</b>	Hereford
<b>Watercourses</b>	Yazor Brook, Widemarsh Brook, Eign Brook and Ayles Brook

### Model Runs and Output Definitions

File name: MMM\_\$\$\_H\_??\_&&\_\*\*\*\*"C"!!\_DDD\_@@@  
 e.g. HER\_CA\_F\_A1\_BA\_0100C35\_25H\_4005

MMM	Model Name
\$\$	Development scenario and phasing - <i>This is used to define the main scenario. A scenario letter will be assigned when the model is issued</i>
H	FAS scenarios - whether or not model includes the Yazor Brook FAS
??	Secondary Scenario
&&	Sensitivity and blockage scenarios, or other specific identifiers that may be needed in the future (Note: naming convention to work back from z to avoid confusion with development scenarios [skip xx])
****	Return period
"C"!!	Climate change allowance
DDD	Hydrological scenario - Storm duration of the model in hours
@@@	Version number of the model
NB	Where inserted after && it represents the removal of the Merton Meadow Car Park access Bridge, WB2368Bu. This has been applied in large events only to resolve model stability issues.

#### Models (MMM)

HER	Full Yazor Brook (Hereford) hydraulic model (including CRD [Credenhill] and ESG [Edgar Street Grid] domains).
-----	---

#### Model Topographic Scenarios (\$\$)

The first letter represents a particular overarching scenario type (e.g. pre development or final development). A new first letter is defined for additional works such as a stand alone FRA study. The second letter represents subsets or versions of the defined scenario type with the exception of AA which can only have one version.	
B( )	This represents present day and is updated accordingly as development and mitigation options progress. The first letter "B" should remain the same, while the second letter can be updated as time progresses.
BA	Scenario reflects the Present Day (last updated February 2018). The main changes from the baseline scenario (AA) include: The Yazor Brook FAS; Jewsons / Canal Road culvert; City Link Road and culvert - all constructed. The model also includes the proposed Widemarsh Brook diversion between Widemarsh Street and Canal Road, and the CLR attenuation pond, based on draft design information (May 2017). As of Feb 2018 these are expected to be constructed shortly. <b>This is the model that has been issued.</b>

#### FAS Scenarios (H)

The Credenhill Flood Alleviation Scheme (FAS) was implemented to divert flows and enable development in Hereford. The pre FAS option forms a baseline scenario for comparison with ESG development scenarios. No FAS is a past case scenario not an existing case scenario because the scheme is completed.	
F	<b>FAS in operation</b>
B	Blocked FAS, as per scenario F with the scheme complete but with no flow allowed down the scheme.

*Mitigation or secondary scenarios (??)*

Denotes mitigation or secondary options whereby the letter represents a proposed mitigation scheme, while the number represents variants of that scheme (e.g. The letter may represent a culvert upgrade, while the number may represent the specific dimensions to be tested).	
xx	No scenario applied

*Residual Risk/ Sensitivity Scenarios (&&)*

Represents scenarios of residual risk or sensitivity. New scenarios applied as 2 letter identifiers moving backwards from zz.	
xx	No scenario applied

Return period and climate change allowance

Return period represented with 4 digits and climate change represented by "C" followed by the	
0020C00	1 in 20 year
0100C00	1 in 100 year
0100C35	1 in 100 year with 35 % increased flows for consideration of climate change
0100C70	1 in 100 year with 70 % increased flows for consideration of climate change
1000C00	1 in 1000 year

Hydrological Scenarios

25H	25 hour storm duration, full catchment storm.
05H	5.5 hour storm duration to assess flood impacts from the lower catchment

**Model Grid Suffix References (where provided)**

File name example: HER_BA_F_xx_xx_0100C35_5H_25H_40 07_d_Max(maxmax).asc	Grid showing the combined modelled results for the 5.5hr and 25hr model runs. At each location, the maximum value from either scenario is shown.
File name example: HER_BA_F_xx_xx_0100C35_5H_25H_40 07_d_Max(maxmax)_src.asc	Grid showing which source grid the values in the maxmax grids have been taken from (i.e the 5.5hr or the 25hr model run).
HER_BA_F_xx_xx_0100C35_25HR_4007 X_Max	Model run reference  Grid type: dMax               Maximum Depth Grid hMax               Maximum Water level Grid vMax               Maximum Velocity Grid ZUK0Max           Maximum Hazard Grid
Trim001	Denoting that the grid is a trimmed version of the model data and the data request number.

Node	Location	X	Y	Description	Data_Source	Modelling Approach	Approximate Dimensions	Photo Ref	Additional Comments
<b>New and replacement structures installed since first model build</b>									
<b>Yazor Brook</b>									
DC1000suRa	Credenhill Flood Alleviation Scheme, Credenhill	344580	242911	Credenhill Flood Alleviation Scheme - 14.6m side weir spills into concrete structure before passing flow into 2m circular culvert. Water level at weir is controlled by flume structure located immediately downstream (details below)	As built drawings: \\uk.wspgroup.com\central\data\Projects\700226xx\70022687 - Yazor Brook Model Data 1617\MODEL\Supporting_Data\01. Yazor Brook FAS As Built Credenhill 2013	Spill unit used to represent 14.56m side weir.	Side weir length 14.56m, height 0.55m above channel bed level and 2.8m above downstream bed level. Concrete box structure 19.385m long by 2m deep, culvert 2m diameter and 815m long.	N/A	The full length of the culvert has not been modelled - model includes a sufficient length to ensure the downstream boundary does not impact the offtake of flow from the brook.
FLUME	Credenhill Flood Alleviation Scheme, Credenhill	344600	242900	Concrete flume structure used to control water levels at the FAS offtake weir.	As built drawings: \\uk.wspgroup.com\central\data\Projects\700226xx\70022687 - Yazor Brook Model Data 1617\MODEL\Supporting_Data\01. Yazor Brook FAS As Built Credenhill 2013	QH Control defined using output from analysis using the Direct Method Transcritical Solver	Throttle 1m wide and 1.5m high.	N/A	
<b>Widemarsh / Eign Brook</b>									
NewCu1_224	Link Road Culvert - New	351210	240660	New box culvert where brook passes under the City Link Road	As built drawing: \\uk.wspgroup.com\central\data\Projects\700226xx\70022687 - Yazor Brook Model Data 1617\MODEL\Supporting_Data\05. Jewsons & Link Road Culverts As Built Jun 2016	Rectangular conduit	3.3m wide, 1.8m height (bottom 300mm assumed soft bed, 1.5m height used in model)	N/A	
WBDC2U	Canal Road Culvert - replaces WB1702 (WBDCU, WBDC2U) below	351340	240440	Length of culvert was upgraded and is now in place.	As built drawing: \\uk.wspgroup.com\central\data\Projects\700226xx\70022687 - Yazor Brook Model Data 1617\MODEL\Supporting_Data\05. Jewsons & Link Road Culverts As Built Jun 2016	Rectangular conduit			
WB2732CU2	Railway upstream of Millbrook Street	350720	240750	Updated arch geometry at outfall of railway culvert	Hereford ESG Mitigation Supplementary Topo and Channel Survey Feb 2017 [model archive # 13] CS_MG0995.dwg (xs 1.014)	irregular conduit section	1.7m wide arch, 1.15 high.	IMG_0994.JPG	only arch dimensions have been updated. Model units, inverts roughness values etc. have all been retained.
<b>Ayles Brook</b>									
<b>All other structures</b>									
<b>Yazor Brook</b>									
10023cu	Kenchester Road Culvert	343748	243234	Culvert underlying Kenchester RD	Total Surveys 2007 - YB_10023	Culvert	Height = 1.72m x 1.94m wide, length = 6.8m	YB_10023-us face-far	
-	Access Bridge	343967	243206	N/A	N/A	Not Modelled	N/A	N/A	2 x flood relief culverts & old railway bridge also included in TufLOW model
YB_9115cu	Station Rd Twin Arch Culvert	344535	242937	Twin Arch Culvert	Total_Surveys_June_2008 - 2008-07-07 - June2008-XS	Sprung conduit (arch culvert)	Height 1.67m x 2.13m wide (x2) Length = 31.4m	YB_09115-ds face-near	
YB_8518cu	Mill Farm Access Bridge	344960	242697	Thin decked footbridge	Total Surveys 2007 - YB_8518	Culvert (Two adjacent bridges modelled as one structure)	Height = 1.02m x 2.43m wide Length = 38.7m	YB_08518-us face-near	
YB_8304cu	Old Roman Rd / Disused Railway Culvert	345115	242645	Skewed rectangular concrete culvert	Total Surveys 2007 - YB_8304	Culvert	Approx: 1.18m x 3.84m, Length = 46.5m	YB_08304-us face-far, YB_08304-ds face-far	
YB_7829cu	Access Bridge (Congreaves)	345517	242735	Slim dick road bridge	Total Surveys June 2007 - YB_07829	Culvert	Approx: 1.13m x 2.63m, Length = 6.15m	YB_07829-us face-far	
YB_7716cu	Access bridge	345620	242791	Rectangular culvert with trash screen	Total Surveys June 2007 - YB_07716	Culvert with trash screen	Approx: 1.38m x 2.1m, length = 14.55m	YB_07716-us face-far	
YB_6940cu	A480 twin arch Bridge	346329	242840	Brick twin arch road bridge	Total Surveys June 2007 - YB_06940	Arch Bridge	Approx: 1.22m x 1.46m (x2), length = 8.6m	YB_06940-us face far	
YB_6721cu	Stretton Court Farm Access Bridge	346528	242894	Rectangular culvert; stone parapet	Total Surveys June 2007 - YB_06721	Culvert. Parapet included in spill	Approx: 1.26m x 2m Length = 6.1m	YB_06721-ds face-far	
YB_6681abu	Stretton Court Farm Access Bridge	346566	242903	Twin brick arch brick built bridge. Stone parapet	Total Surveys June 2007 - YB_06681	Twin Arch Bridge. Parapet included in spill	Approx: 0.95 x 1.48m (x2), Length = 5.1m	YB_06681-us face	
YB_6561abu	Stretton Court footpath access bridge	346668	242941	Twin brick arch footpath access bridge.	Total Surveys June 2007 - YB_06561	Twin Arch Bridge	Approx: 0.97m x 1.82m (x2), Length: 3.7m	YB_06561-ds face-far	
YB_6048su	Footpath bridge	347146	243085	Arched footpath bridge	Site observation	USBPR bridge	Approx: 3.6m x 0.7m	-	
RR11.5Auw	Weir	347751	242404	Broad crested weir	Site observation	Broad crested weir	N/A	-	
YB04964cu (BOXCULU, RR11.5Acu)	Roman Road Culvert	347750	242395	Roman road rectangular culvert. Stone parapet. Otter pass	Total_Surveys_March_2007 - YB04964	Rectangular conduit. Separate conduit for otter pass	Approx: 1.08m x 3.53m, Length = 8.4m	YB04964 LUS FR	Flood relief culverts under Roman Road included in TufLOW model
CS06Cu (Ber06u)	Huntington House footbridge	348454	241937	Wooden Footbridge	006-Whitecross_High_School_Sept_2003 -drg- CROSS SECTIONS	Bernoulli unit	Approx: 0.94m x 4.4m, length = 4.9m	-	From Whitehouse Scooh FRA model
CS08Bu (BRH8u)	Hungtington Court access bridge	348519	241901	Stone triple arch bridge with wooden rails.	006-Whitecross_High_School_Sept_2003 -drg- CROSS SECTIONS	Triple arch Bridge	Approx: 1.15m x 7.5m, Length = 6.3m	-	From Whitehouse Scooh FRA model
N/A	Sluice - outlet from Huntington Court pond	348715	241826	Sluice gate	-	Not modelled	-	-	From Whitehouse Scooh FRA model
CS14 (Ber14u)	Footbridge	348768	241790	Footbridge	006-Whitecross_High_School_Sept_2003 -drg- CROSS SECTIONS	Bernoulli unit	Approx: 0.9m x 6.5m, Length = 1.8m	-	From Whitehouse Scooh FRA model
CSPB (BRPBu)	Pipe crossings	349014	241494	Pipe crossings	006-Whitecross_High_School_Sept_2003 -drg- CROSS SECTIONS	Orifice	Approx: 3.1m x 1m	-	From Whitehouse Scooh FRA model
YB3055Cu	Three Elms road bridge	349095	241451	Rectangular road bridge	Total_Surveys_November_2005 - YB03055	Rectangular culvert	approx: 3.4m x 2.45m, Length = 20.6m	-	
YB3007oru	Three Elms Gauge - weir & footbridge	349124	241450	Gauge STN Weir underlying a steel footbridge.	Total_Surveys_November_2005 - YB3007	Orifice	Approx: 0.82m x 3.01m, Length = 1.34m	-	
YB2634bu	Footbridge	349414	241288	Footbridge	Total_Surveys_November_2005 - YB2634	USBPR Bridge	Approx: 0.71m x 5.15m, Length = 3.84m	-	
YB2124Cu	Yazor Road Bridge	349500	240812	Rectangular bridge	Total_Surveys_November_2005 - YB02124	Culvert	Approx: 0.89m x 5.48m, Length = 19.7m	-	
YB2028bu	Footbridge	349574	240767	Timber footbridge.	Total_Surveys_November_2005 - YB2028	USBPR Bridge	Approx: 2.16m x 7.62m, Length = 3.31m	-	
YB1861bu	Footbridge	349692	240657	Footbridge	Total_Surveys_November_2005 - YB01861	USBPR Bridge	Approx: 0.97m x 5.31m, Length = 2.35m	-	
YB1761Su	Weir - Widemarsh Brook bifurcation	349764	240673	Weir	Total_Surveys_November_2005 - YB01761	Spill	-	-	
YB1607BU	Footbridge	349911	240671	Steel footbridge	Total_Surveys_November_2005 - YB01607	Bernoulli unit	Approx: 1.54m x 7.08m, Length = 1.35m	-	
YB1221Cu	Yazor Brook Plough Lane Culvert	350285	240575	Rectangular culvert with Trash screen	Total_Surveys_November_2005 - YB01221	Orifice & conduit	Approx: 1.23m x 1.91m, Length = 217.8m	-	
YB0982 (YBBCIU, YBBCU)	Bulmers culvert	350442	240402	Rectangular concrete culvert.	Total_Surveys_November_2005 - YB0982cu	Rectangular Conduit. Orifice for culvert entrance. Inverted syphons under footpath	Approx: 1.6m x 5.02m, Length = 160m	-	
YB0671	Sluice	350586	240149	Sluice gate	Total_Surveys_November_2005 - YB0671	Spill	N/A	-	
YB065 (YBCCIU)	Friars Street culvert	350593	240126	Rectangular culvert	Total_Surveys_November_2005 - (YB-XS) YB0656, (YB-LS)	Conduit. Orifice for entrance.	Approx: 1.15m x 2.04, Length = 390m	-	Culvert shortened. QH boundary extracted from full model and applied to downstream boundary
<b>Widemarsh / Eign Brook</b>									

Node	Location	X	Y	Description	Data_Source	Modelling Approach	Approximate Dimensions	Photo Ref	Additional Comments
<b>New and replacement structures installed since first model build</b>									
WB3942SU	Widemarsh Brook bifurcation weir	349755	240674	Weir	Total_Surveys_November_2005 - WB03942	Spill	N/A	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS far Ch: 3912	
WB3939	Widemarsh Brook bifurcation Weir And Footbridge	349756	240674	Weir and Foot bridge with 3 pipes	Total_Surveys_November_2005 - WB03942	Orifice	Approx: 1.2m x 4.9m, Length = 10.5m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS far Ch: 3913	
WB3681Bu	Footbridge	349837	240809	Thin deck timber footbridge	Total_Surveys_November_2005 - WB03943	Bridge - USBPR	Approx: 0.96m x 4.63m, Length =	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS Ch: 3651	
WB3293BU	Power station access bridge & pipe crossings	350184	240771	Rectangular culvert with pipe crossings	Total_Surveys_November_2005 - WB03293	Orifice	Approx: 1.41m x 5.37m, Length: 8.0m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking US far Ch: 3263	Skew angle = 63 degrees
WB3210bu	Widemarsh Brook Disused Railway Bridge	350263	240783	Rectangular stone walled bridge underlying disused railway line.	Total_Surveys_November_2005 - WB03210	USBPR Bridge	Approx: 1.78m x 3.09m, length = 15.1m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 3180	
WB3157BU	Footbridge	350297	240769	Slim deck concrete footbridge plus pipe crossing	Total_Surveys_November_2005 - WB03157	Orifice	Approx: 1.9m x 1.5m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking US far Ch: 3127	
WB2732CU1	Old Railway Culvert	350718	240757	Rectangular culvert with trash screen under disused railway. Changes to arch culvert along length	Total Surveys - November 2005, Section WB02732	Rectangular & irregular Conduit units	Approx: 1.045m x 2.17m Length = 34m.	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS far Ch: 2702, Looking US near Ch: 2668	Downstream arch geometry updated based on check survey May 2017 as part of ESG mitigation project.
WB2615BU	Millbrook Street road bridge	350797	240761	Rectangular culvert	Total Surveys - November 2005, Section WB2615	Orifice	Approx: 0.74m x 3.71m, Length = 7.9m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 2585	
WB2511Cu	Edgar Street road bridge	350905	240749	Rectangular concrete culvert	Total Surveys - November 2005, Section WB02511	Orifice	Approx: 0.72m x 3.32m, Length = 18m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS far Ch: 2481	
WB2368BU	Merton Meadow car park access bridge	351026	240702	Rectangular concrete bridge	Total Surveys - November 2005, Section WB02368	Orifice	Approx: 1.13m x 6.05m, Length = 8.2m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS far Ch: 2338	
WB2237 (WB2237CU & C2U)	Widemarsh steet Culvert	351107	240781	Twin arch stone walled culvert.	Total Surveys - November 2005, Section WB02237	Twin Culvert	Approx: 1.38m x 2.03m (x2), Length: 26.7m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 2207	
-	Access Bridge	351125	240772	Rectangular access bridge	Total Surveys - November 2005, Section WB02202	Not modelled (minor obstruction)	Approx: 3m x 1.1m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking US far Ch: 2207	
WB1702 (WBDCU, WBDC2U)	Canal Road Culvert	351337	240434	Twin Brick Arch Culvert	Total Surveys - November 2005, Section WB01702	Irregular conduit units. Orifice for culvert entrance D1	Approx: 2m x 2m & 1.2m x 1.2m, Length = 25m.	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 1672	Continuous culvert with change in section  STRUCTURE WAS REPLACED IN 2016 AS PART OF THE LINK ROAD WORKS - SEE DETAILS ABOVE
WBDC3U	Morrisons culvert	351355	2403434	Rectangular concrete culvert	Total Surveys - November 2005, WB EB Long section	Irregular conduit.	Approx: 3 x 1.6m. Length ~ 256m	N/A	Continuous culvert with change in section
WBDC8U	Commercial Road culvert	351578	240374	Arched concrete culvert	Total Surveys - November 2005, WB EB Long section, EB01408		Approx: 3.2 x 2.4m, Length 12.25m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking US near Ch: 1408	Continuous culvert with change in section
EB1375Cu	Eign Brook KFC access bridge	351614	240323	Concrete Arch culvert	Total Surveys - November 2005, Section WB01702	Orifice	Approx: 1.55m x 2.42m, Length = 20.4m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 1375	
EB1157BU	Footbridge	351754	240181	Slim deck access bridge	Total Surveys - November 2005, Section EB01157	Bernoulli unit	Approx: 0.95 x 4.02m Length = 5.24m ( skew angle = 62 degrees)	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 1157	Bernoulli Loss and spill updated May 2017 as part of ESG mitigation Project.
EB0929BU	Eign Brook railway culvert	351835	239974	Stone walled arch culvert	Total Surveys - November 2005, Section EB0929	Arch Bridge	Approx: 2.63m x 4.25m, Length = 11.4m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 929	
EB0711CU	Ledbury Road bridge	352014	239850	Arch road bridge	Total Surveys - November 2005, Section EB0711	Irregular conduit	Approx: 1.32m x 6.12m, Length = 24m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 711	
EB0067BU	Eign Road bridge	352216	239299	Rectangular culvert changing to arch culvert	Total Surveys - November 2005, Section EB0067 & EB00045	USBPR bridge	Approx: 4.2m x 2.2m (3.8 x 3.4 ds), Length 22m	WIDEMARSH & EIGN BROOKS PHOTOS - Looking DS near Ch: 67, Looking US far Ch: 45	Change to arch not modelled - dominated by DS boundary
<b>Ayles Brook</b>									
AY0395	Old railway culvert (Ayles Brook	350880	241043	Rectangular culvert	Site observation	Not modelled - upstream extent of	Rectangular culvert approx. 1.5m by 1m	-	
-	Footbridge into retail park	350961	240945	Slim deck footbridge	Site observation	Not modelled - high level bridge,	N/A	-	
AY0236	Access Bridge	351016	240951	Access bridge into retail park	Site observation	Not Modelled - wide structure with high soffit, unlikely to cause obstruction flow	Approx. 6m by 3m	IMAG0326.jpg	
AY0186c	Ayles Brook - under old canal	351049	240937	Arched culvert - conveys flow from Ayles brook along the old canal alignment, outfalls into Widemarsh Brook under the Widemarsh Street culvert	Site observation	Sprung arch conduit	Approx. 1.5m by 1m (spring level approx. 0.75m fro	IMAG0389.jpg	