Appendix G - Modelling Technical Notes

JBA Project Code	2022s0768
Contract	Birmingham SFRA and Water Cycle Study
Client	Birmingham City Council
Day, Date and Time	24 February 2023
Author	Rebekah Alford BSc Georgie Troy
Reviewer / Sign-off	David Kearney BSc MSC MCIWEM C.WEM
Subject	Updated Modelling

1 Introduction

1.1 Updating the SFRA Modelling

The Birmingham City Level 1 SFRA provides a comprehensive and robust evidence base on flood risk issues to support the replacement of the Birmingham Development Plan (BDP) and associated Planning Policy documents using the best available information. The Environment Agency's 'Flood Map for Planning' is used to represent the flood zones and levels of flood risk and incorporates updated modelled data where available.

The Planning Practice Guidance on Flood Risk and Coastal Change was updated on the 25 August 2022 which resulted in the need to update the SFRA. These updates include the requirement for:

- updated climate change modelling for all sources of flood risk
- Definition of the functional floodplain (Flood Zone 3b) based around the 3.3% AEP event, rather than the 5% AEP event under previous guidance.

2 River Tame

The hydraulic modelling of the River Tame has been updated to simulate the 3.3% AEP event with updated Upper End climate change allowances for the management catchment (as quoted in Table 2-1).

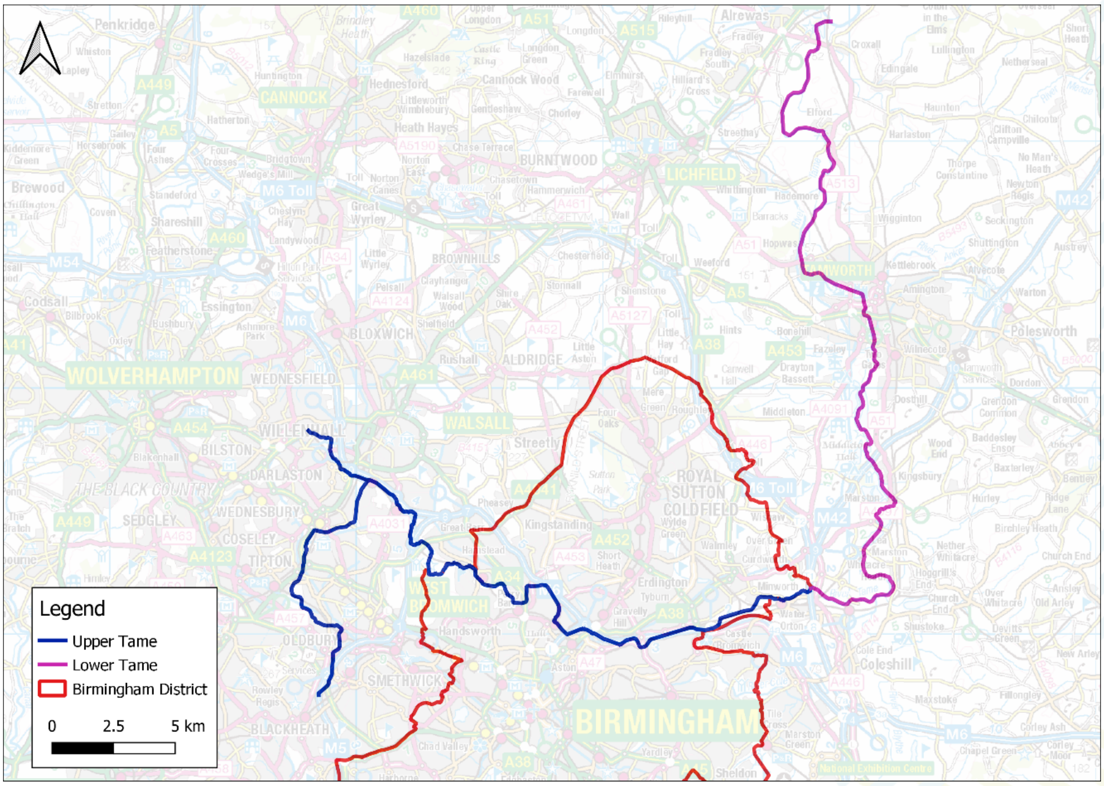

Figure 2:1: River Tame model extents

The River Tame modelling was developed for the River Tame Flood Risk Management Strategy (FRMS) in 2009 and consists of two 1D models for the Upper and Lower Tame in Flood Modeller and then a third 1D-2D FM-TUFLOW model.

The Upper Tame is a 1D FM model which consists of the upper reach of the Tame and its tributaries and flows through Birmingham as shown in Figure 2:1. The second 1D FM model is the Lower Tame and this represents the Tame from Water Orton to the confluence with the River Trent. The flow outputs of the Upper Tame model are used as inflows for the Lower Tame model.

The third model is a 1D-2D FM-TUFLOW model, spanning a shorter section of the Upper Tame, as shown in Figure 2:2.

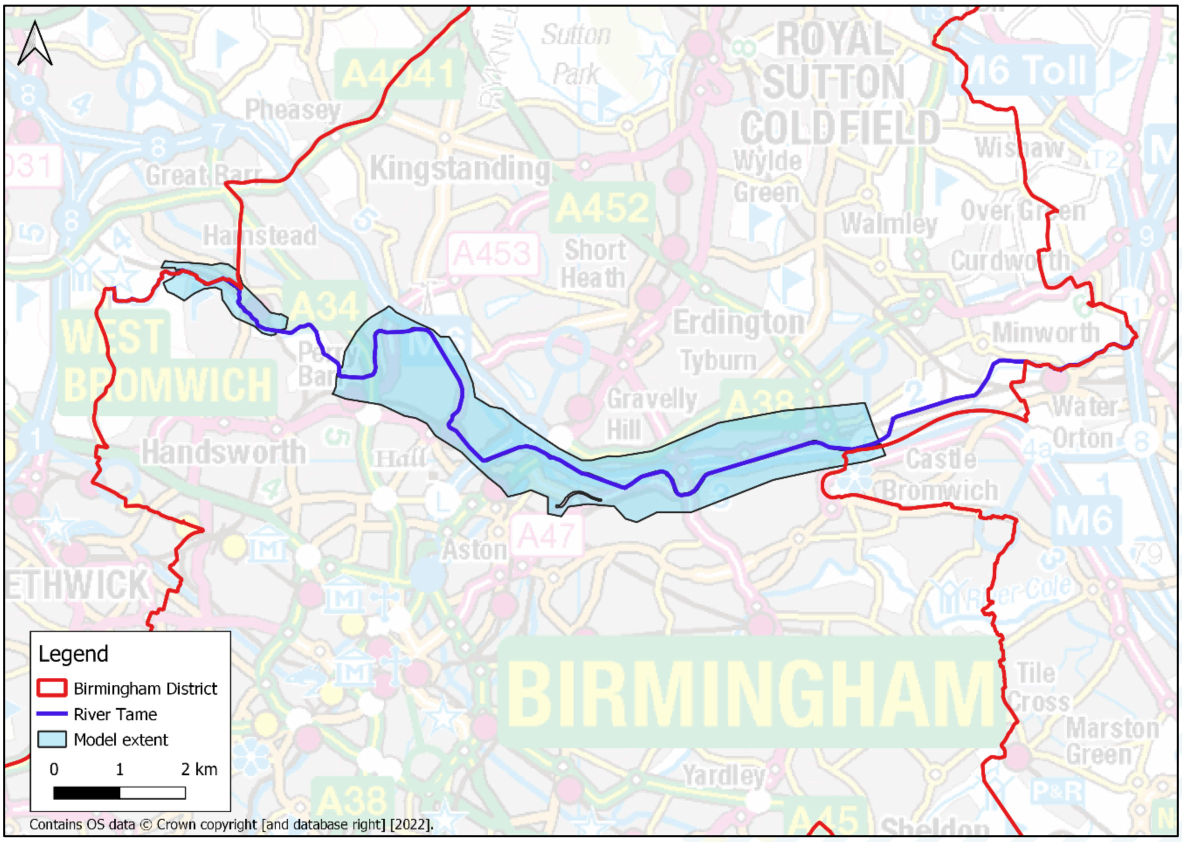

Figure 2:2: Extents of 1D-2D linked model

The following events were simulated for each model:

- 3.3% AEP
- 3.3% AEP CC - Upper end allowances
- 1.0% AEP
- 1.0% AEP CC - Upper end allowances

2.1 Method

2.1.1 Estimating the 3.3% AEP flood flow

Flows for the 3.3% AEP event were not available with the existing model files and had not been derived in the existing hydrological study. The model though is schematised with FEH Boundaries as inflows, meaning appropriate flows can be derived by adjusting the Flood Return Period in the boundary unit to 30 years.

From the FEH Rainfall data a flow hydrograph for each inflow point is then calculated by Flood Modeller and applied to the hydraulic model. The flow hydrographs produced for each inflow point are consistent with the shape of the respective 20 and 50 year flow hydrographs. Checks for consistency have shown that the 30 year hydrographs are reasonable and fit between the 20 and 50 year hydrographs.

A more comprehensive updating of the hydrology for the River Tame is considered to be beyond the scope of the project as this modelling is strategic in nature and aims to derive datasets that can be used consistently with existing flood risk datasets. Furthermore, there are complexities in re-running the model and the age of the model which means updating the model hydrology may become a more complex and expensive undertaking.

2.1.2 Applying the climate change guidance

In 2018, the government published new UK Climate Projections (UKCP18). The Environment Agency used these projections to update their climate change guidance for new developments with regards to updated fluvial and rainfall allowances which were released in July 2021.

Table 2-1 shows the updated peak river flow allowances that apply in Birmingham for fluvial flood risk for the Tame, Anker and Mease Management Catchment (last updated in July 2021). These allowances supersede the previous allowances by River Basin District. The River Tame model was updated with the upper end estimates for the 2020s, 2050s and 2080s for the 3.3% and 1% AEP events.

Table 2-1: Peak river flow allowances for the Management Catchment in Birmingham

Management Catchment	Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Tame, Anker and Mease	Upper end	22%	30%	51%
	Higher central	11%	17%	30%
	Central	10%	15%	24%

2.1.3 Mapping Results Overview

This section describes the 1D mapping process that were used in Flood Modeller (FM) to produce the flood extent results, for the 1D sections of the models. The 2D sections of the model were processing using TUFLOW_to_GIS to create output which were merged with the 1D results.

2.1.4 The Upper Tame 1D-2D section

The method described below was used for mapping all the 1D results, the same methodology was using for the combined FM/TUFLOW model area shown in the figure. Due to the size of the model, it was sub divided for processing and remerged. The digital terrain model (DTM) was resampled to 4m to allow FM to successfully run from the 2022 1m Composite LiDAR from Environment Agency.

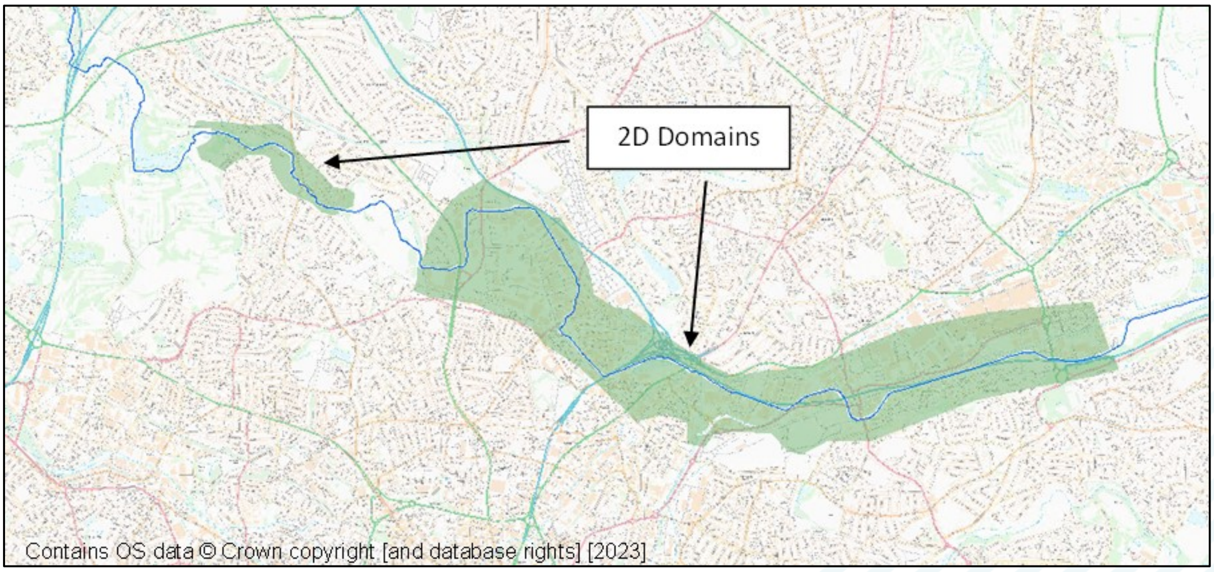

Figure 2:3: Active 2D areas in the Upper Tame

Figure 2:3 shows the active 2D areas in the Upper Tame. The 1D areas were used to infill the channel with these areas. Outside the 2D domain area the 1D cross section were extend were mapped through triangulation as detailed in the following sections. Once both processes are complete the 2D and 1D mapped outputs are merged into a single flood envelope.

2.1.5 Required data/files

The following files were required to perform the 1D calculation:

DTM (Digital Terrain Mapping) of the study area trimmed to focus key areas to improve efficiency.

A polyline shapefile containing all 1D cross sections to be mapped, with the cross-section references named same as they appeared in the FM model, so water levels from the ZZN were correctly attributed to the relevant cross sections.

References had to attributed under the heading 'node' or 'label'.

Tame_XS_Upper_B

FID	Shape *	label
0	Polyline	TM099183
1	Polyline	TM099083
2	Polyline	TM098983
3	Polyline	TM098883
4	Polyline	TM098783
5	Polyline	TM098763
6	Polyline	TM098683
7	Polyline	TM098683D
8	Polyline	TM098640
9	Polyline	TM098640D
10	Polyline	TM098610

Figure 2:4: Polyline shapefile showing 1D cross sections

2.1.6 Methodology

The relevant GIS files including 1D sections were loaded into FM ensuring nodes were correctly labelled as above. The relevant section of the DTM had to loaded to be able to perform the 1D mapping calculation (ASCII format).

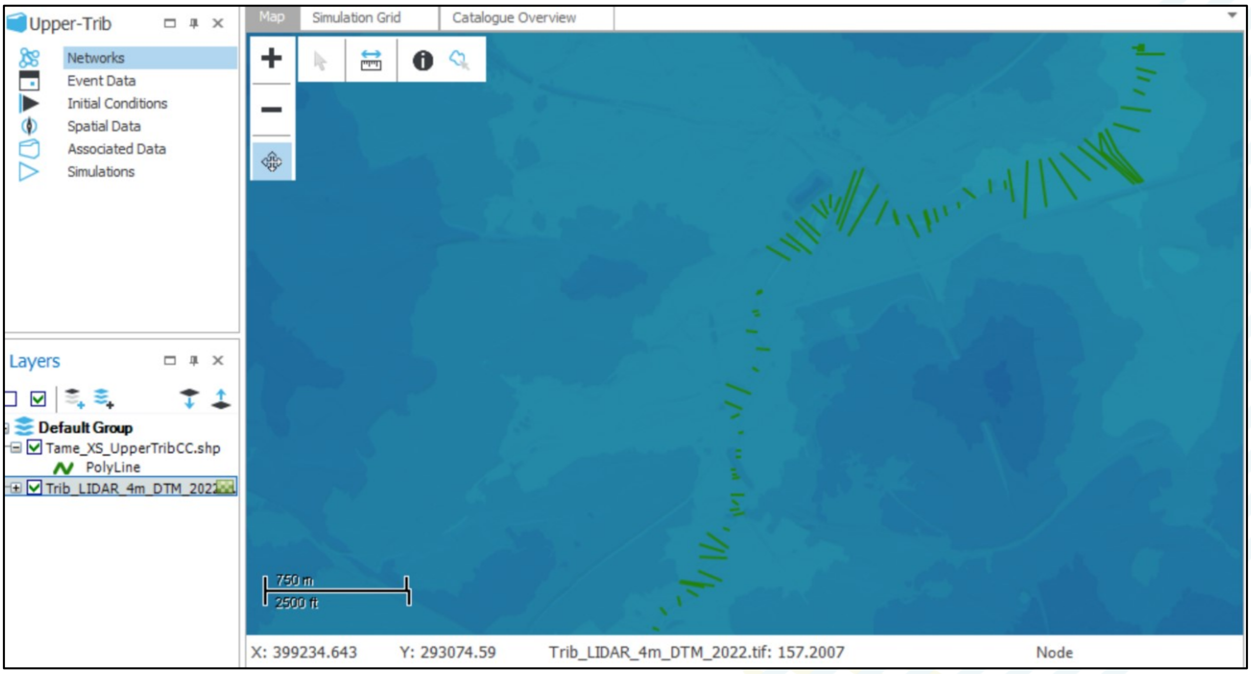

Figure 2:5: Section of the Upper Tame run in 1D

Figure 2:5 shows an area of the Upper Tame which is run completely in 1D. The grid shown is a DTM. Cross sections have been extended.

2.1.7 Creating a tin

Flood Modeller required a tin shapefile to be created to project and triangulate water levels between cross sections. The tin creator creates individual triangles connecting the centre and edges of cross sections to all other points. These can be deleted for areas that should not have flow going across.

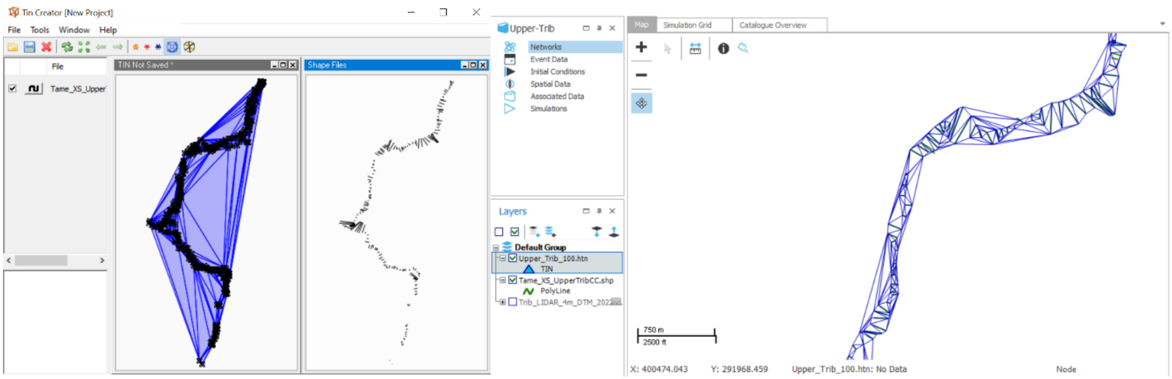

Figure 2:6: Tin shapefile created to project and triangulate water levels

Figure 2:6 shows the Tin Creator for the whole subsection on the left and the saved altered TIN (.htn) for the section shown in Figure 2:5.

2.1.8 1D Results data

With a successful tin file created the depth results were assign the data to the tin, via the zzn file from the 1D model file results for the relevant return period and scenario.

2.1.9 Running 1D Flood Map

Once the appropriate results were loaded to the tin FM was used to create 1D Flood Map in the .asc format.

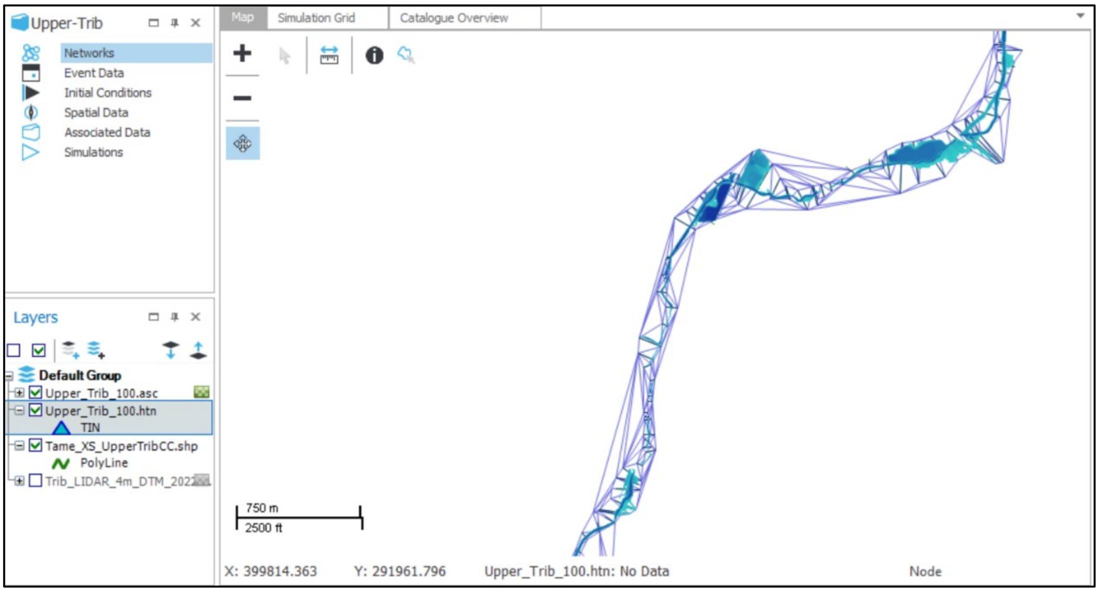

Figure 2:7: 1D calculation output

Figure 2:7 shows the output of the 1D calculation run through the mapping tool. Flood Modeller has subtracted provided water level results from the trimmed DTM and using the tin created, interpolated levels between sections.

2.1.10 Outputs and quality control

The process was repeated for each different scenario, with the cross sections and TIN's adjusted to reflect as accurately as possible the flood extents, without creating glass walls and isolated flooding. For this model the first iteration of depth grids were checked and adjustments made, before The WEM Flood mapping Efficiency Tools were used to create the flood extents as .shp polygons. The different 1D depth extents (.shp files) (split because of the processing size of the files and the capacity of FM) were merged for each scenario and with the appropriate 2D results.

The merged extents were cleaned using the Environment Agency NAFRA2 toolbox process (Removal holes (dry islands) less than 200m^2 & removal wet islands less than 10m^2).

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3 River Cole and Hatchford Brook

The hydraulic modelling of the River Cole and the Hatchford Brook have been updated to simulate the 3.3% AEP event with updated Upper End climate change allowances for the management catchment (as quoted in Table 3-1).

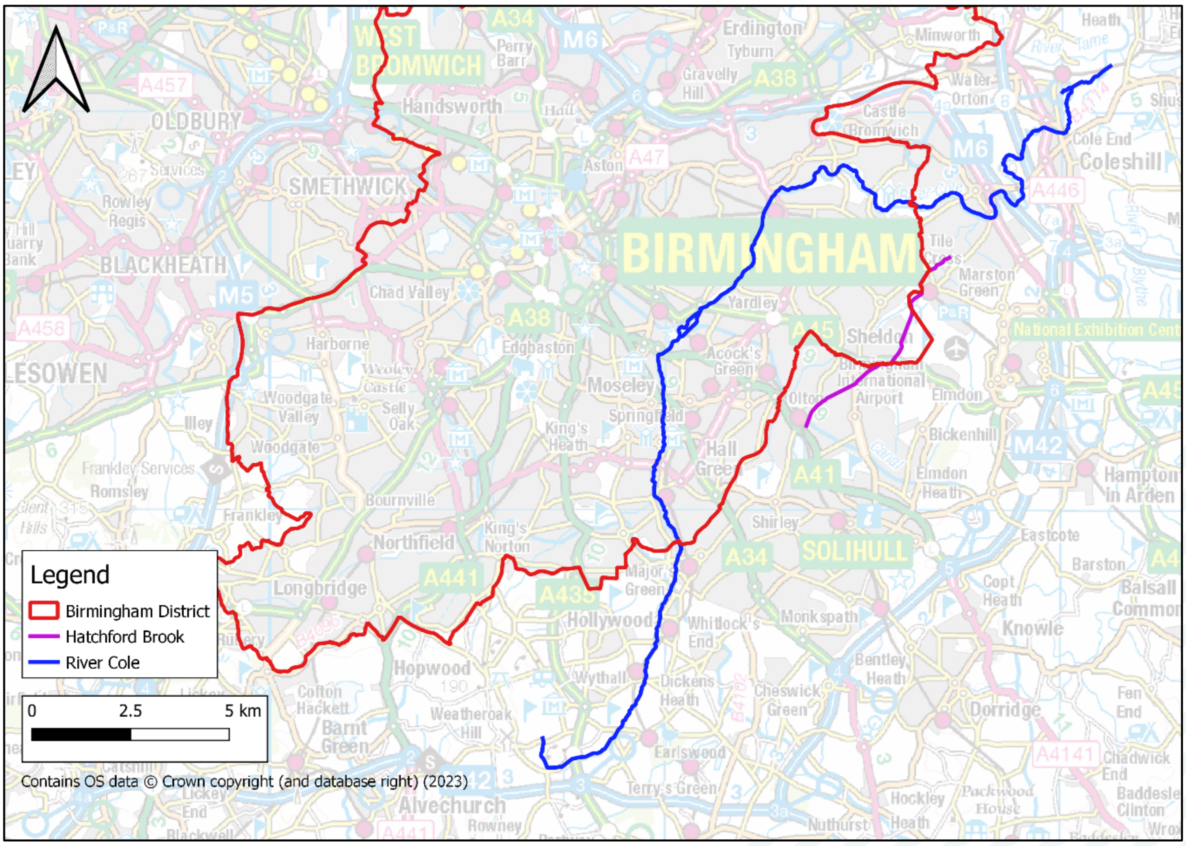

Figure 3:1: River Cole and Hatchford Brook model extents

The River Cole modelling and Hatchford Brook modelling were updated to support the replacement of the Birmingham Development Plan (BDP) and associated Planning Policy documents. They both consist of one 1D-2D model in Flood Modeller and TUFLOW (one model for the River Cole and another for the Hatchford Brook).

The River Cole model is a 1D-2D FM-TUFLOW model which consists of the River Cole flowing from the River Blythe approximately 1.1km east of Coleshill, through the south-east of Birmingham District, south to Hill Lane in Weatheroak Hill. This is shown in Figure 3:1.

The Hatchford Brook is a 1D-2D FM-TUFLOW model which flows in a north-easterly direction from Olton, through the south-east of Birmingham District, to Chelmsley Wood where it converges with the Low Brook to form the Kingshurst Brook. This is shown in Figure 3:1.

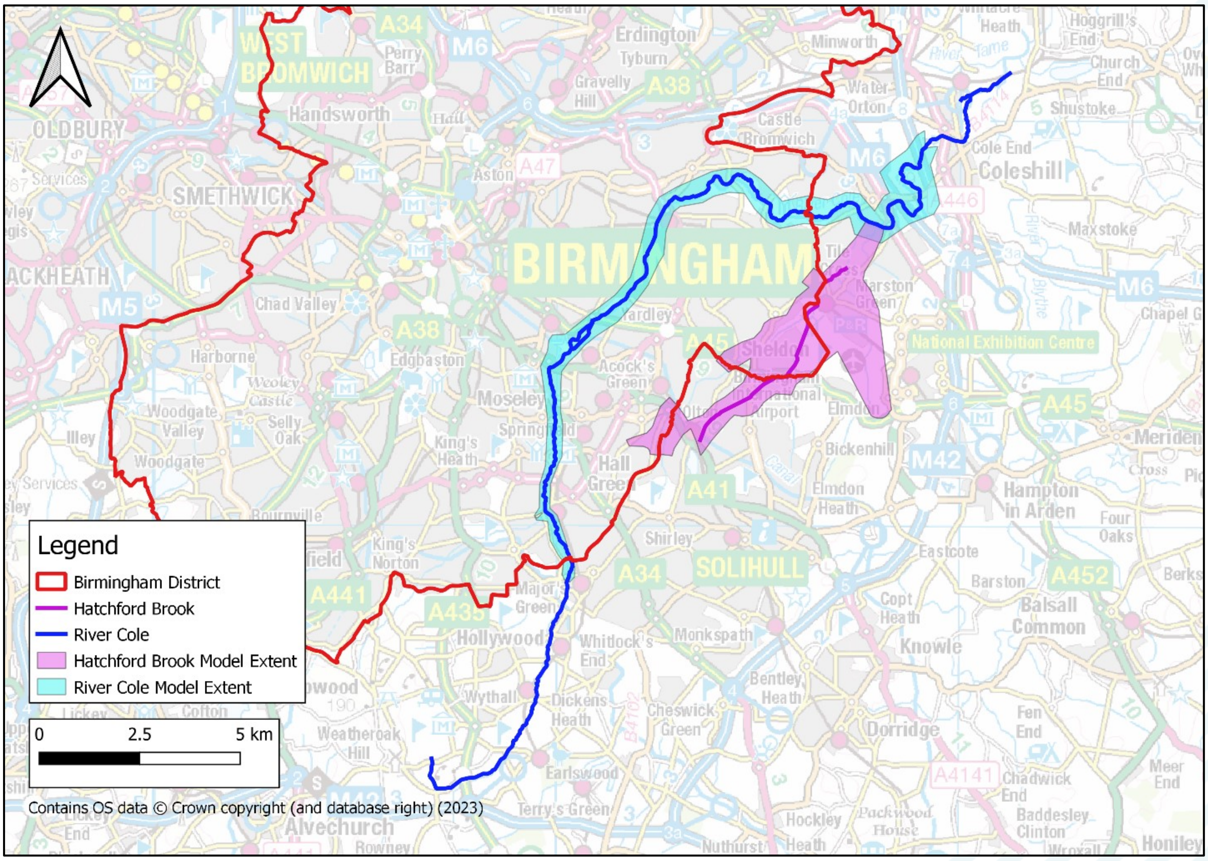

Figure 3:2: Extents of 1D-2D linked models

The following events were simulated for the River Cole model:

- 3.3% AEP present day
- 3.3% AEP CC - Central allowances
- 3.3% AEP CC - Higher Central allowances
- 3.3% AEP CC - Upper End allowances
- 1.0% AEP CC - Higher Central allowances
- 1.0% AEP CC - Upper End allowances

The following events were simulated for the Hatchford Brook model:

- 3.3% AEP CC - Central allowances
- 3.3% AEP CC - Higher Central allowances
- 3.3% AEP CC - Upper End allowances

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3.1.2 Rectifying model files

In order to complete the model simulations for both the River Cole and the Hatchford Brook, several model files had to be updated. This involved reloading the IED event files into the IEF simulation in Flood Modeller. Furthermore, all the layers of the model in TUFLOW which had MIF files needed to be re-exported in MapInfo. Finally, the file paths stated in the .tcf and .tgc files for both the River Cole and the Hatchford Brook were corrected due to these being previously directed to a separate computer drive.

3.1.3 Applying the climate change guidance

In 2018, the government published new UK Climate Projections (UKCP18). The Environment Agency used these projections to update their climate change guidance for new developments with regards to updated fluvial and rainfall allowances which were released in July 2021.

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