enzygo
environmental consultants

Hydrological Assessment

Loddon: Western Watercourses

Abley Letchford

SHF.1229.003.HY.R.002.B

Contact Details:

Samuel House
1st Floor
5 Fox Valley Way
Stocksbridge
Sheffield
S36 2AA

tel: 0114 321 5151
www: enzygo.com

Loddon: Western Watercourses

Project:	SHF.1229.003.HY.R.002.B - Hydrological Assessment
For:	Abley Letchford
Status:	Issued
Date:	June 2025
Author:	Helena Du-Roe BSc (Hons), MSc, MCIWEM – Principal Hydrologist
Approver:	Daniel Alstead BSc (Hons), MSc, MCIWEM, C.WEM - Director of Hydrology

Disclaimer:

This report has been produced by Enzygo Limited within the terms of the contract with the client and taking account of the resources devoted to it by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

Enzygo Limited Registered in England No. 6525159

Registered Office Gresham House, 5-7 St. Pauls Street, Leeds, England, LS1 2JG

Contents

Contents **1**
1.0 Introduction **3**
1.1 Background 3
1.2 Purpose of the Report 4
1.3 Initial Choices of Approach 4
2.0 Hydrological Assessment **6**
2.1 Catchment Hydrology 6
2.2 FEH Statistical Method (Adjusted Catchment) 11
2.3 ReFH2 Method 18
2.4 Limitations 21
2.5 Analysis of Peak Flow and Choice Going Forward 22

Tables & Figures

Figure 1.1: Modelled Watercourses 4
Figure 2.1: Catchment Boundaries and 2m DTM LiDAR Data 6
Figure 2.2: Catchment Boundaries and Watershed Analysis 7
Figure 2.3: Catchment Boundaries and Bing Mapping 7
Table 2.1: Catchment Descriptors from the FEH Webservice Catchment 8
Figure 2.4: Soils Mapping 9
Figure 2.5: 2025 Urbanised Areas 11
Figure 2.6: Gauging Station Catchment Location Comparisons 13
Table 2.2: Catchment Descriptor Comparison – The Cut at Binfield 13
Table 2.3: Catchment Descriptor Comparison – Blackwater at Swallowfield 14
Table 2.4: Catchment Descriptor Comparison – Loddon at Sheepbridge 14
Table 2.5: Catchment Descriptor Comparison – Thames at Kingston 14
Table 2.6: Catchment Descriptor Comparison – Pang at Pangbourne 14
Table 2.7: Catchment Descriptor Comparison – Enborne at Brimpton 15
Figure 2.7: QMED Comparison 16
Figure 2.8: Initial Pooling Group 17
Figure 2.9: Reviewed Pooling Group 17
Figure 2.10: Goodness of Fit 18
Table 2.8: Pooled Group Growth Fittings and Flood Frequency 18
Figure 2.11: Schematic Representation of the ReFH Model 19
Table 2.9: Summary of the Six ReFH Model Parameters 19
Table 2.10: ReFH2 Parameters 20
Table 2.11: ReFH2 Method Peak Flows (Summer Profile) 20
Table 2.12: Summary of Results 20
Figure 2.12: Graph Summary of Results 21
Table 2.13: Summary of Results 23

Appendices

Appendix 1 - FEH Statistical Outputs
Appendix 2 - ReFH2 Calculation Logs
Appendix 3 - Full ReFH2 Hydrographs

1.0 Introduction

1.1 Background

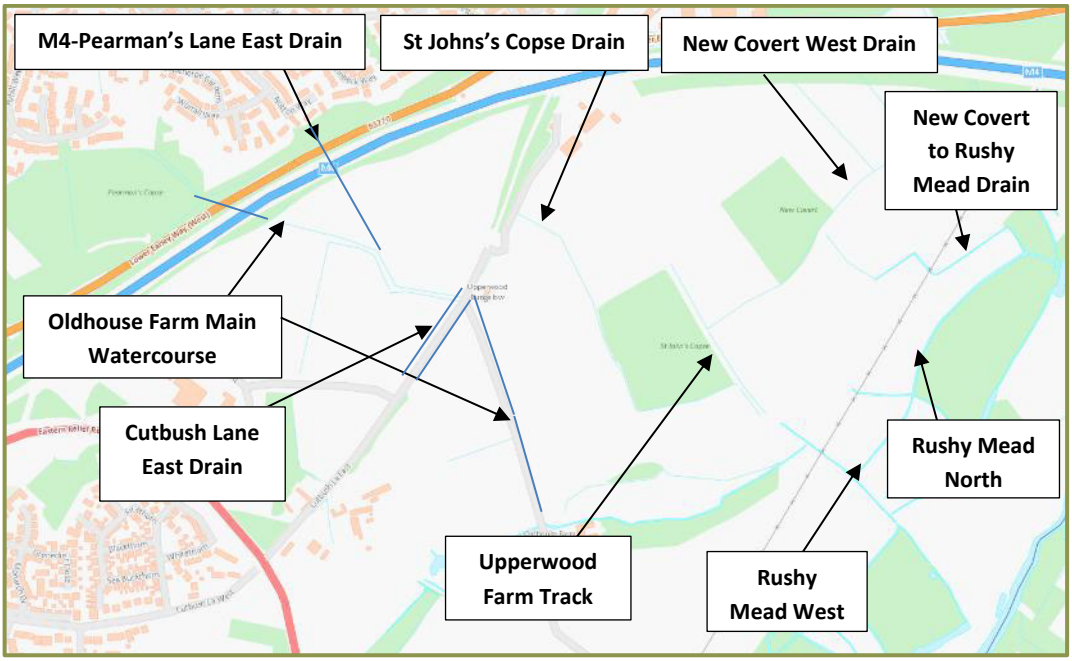
1.1.1 Enzygo Ltd were commissioned by Abley Letchford Partnership Ltd to undertake an updated hydraulic modelling exercise to inform fluvial (river) flood risk, associated with the Oldhouse Farm Main watercourse and the associated tributary network. The study area is centred at (NGR) 474073, 169250.

1.1.2 Enzygo previously prepared a modelling report (Document Reference. SHF.1229.003.HY.R.001.A, dated October 2021), supported by a Hydrologcial Assessment (Document Reference. SHF.1229.002.HY.R.004.A, dated April 2023). The updated modelling exercise/hydrologvial assessment utilsies latest modelling software and data sets, but aslo follows latest modelling guidance documents.

1.1.3 A desktop study identified a number of tributary watercourses (ordinary watercourses) located within the model domain. These watercourses are described below and in Figure 1.1:

- Oldhouse Farm Main Watercourse - The main watercourse that flows through the model. Nearly all other watercourse within this model connect to the Oldhouse Farm Main Watercourse.
- M4-Pearman's Lane East Drain - Shown to transfer flows from the north of the M4 to the south, before discharging into Oldhouse Farm Main Watercourse.
- Cutbush Lane East Drain - Located in the western extent of the model domain, this watercourse flows to the northeast before discharging into Oldhouse Farm Main Watercourse.
- St John's Copse Drain - A watercourse located to the north of St John's Copse, that flows south and adjacent to the western side of St John's Copse before eventually discharging to Oldhouse Farm Main Watercourse.
- Upperwood Farm Track (watercourse) - A short section of watercourse, which flows south and is located on the eastern boundary of the St John's Copse, before discharging to St John's Copse Drain.
- New Covert West Drain - A short section of watercourse located to the north east of Upperwood Farm Track, which flows south west before discharging to the aforementioned watercourse.
- New Covert to Rushy Mead Drain - Watercourse connecting New Covert West Drain to Rushy Mead North (watercourse). The watercourse begins at New Covert and is orientated north west to east, with the direction of flow being east.
- Rushy Mead West (watercourse) - Located in the lower extent of the model domain and flows discharge into St John's Copse Drain.
- Rushy Mead North (watercourse) - This watercourse is located in the lower extent of the model. Flows from New Covert to Rushy Mead Drain enter this watercourse. Flows exit the model from the lower extent of Rushy Mead North.

Figure 1.1: Modelled Watercourses



1.2 Purpose of the Report

1.2.1 The purpose of this report (SHF.1229.003.HY.R.002.B, June 2025) details the methodology and results of a hydrological assessment, which represent the peak flow inputs to the Oldhouse Farm main watercourse hydraulic model . This Hydrological Assessment report should be read in conjunction with the modelling report and will be included as Appendix 1 of the modelling report (SHF.1229.003.HY.R.001.B, June 2025).

1.2.2 The Environment Agency Flood Estimation Calculation Report Template (LIT 65087) has been reviewed and been used to revise the hydrological assessment. This report discusses the following methods of flood estimation:

- The FEH statistical method - An "improved" set of procedures has replaced most of the original 1999 FEH statistical methods for ungauged sites; and
- The Revitalised Flood Hydrograph (ReFH2) method - This has replaced the original 1999 FEH rainfall-runoff method for most applications. ReFH2 uses a similar rainfall-runoff model as ReFH1 but with improved procedures for estimating model parameters and defining the design storm.

1.3 Initial Choices of Approach

1.3.1 Based on modeller experience, the methodology assumed to provide the most representative flows will be those derived from the FEH statistical method. This is due to being able to introduce a donor gauging station to assist with flow derivation, while taking into account a number of catchment descriptors (these will be checked to ensure they are representative of the catchment).

1.3.2 Hydrograph shapes will be derived from ReFH2, given that observed data is not available for this catchment at the detailed inflow locations.

1.3.3 The ReFH2 method will also be used to derive peak flow estimate for comparison against the FEH statistical flows.

2.0 Hydrological Assessment

2.1 Catchment Hydrology

River Basin District

2.1.1 The study area resides within the Thames River Basin District (RBD) and the Loddon and tributaries Management Catchment. The climate change allowances within the Dorset Management Catchment are 14% ('Central' estimate), 23% ('Higher End' estimate) and 46% ('Upper End' estimate) for the Total Potential Change anticipated by the 2080's[1].

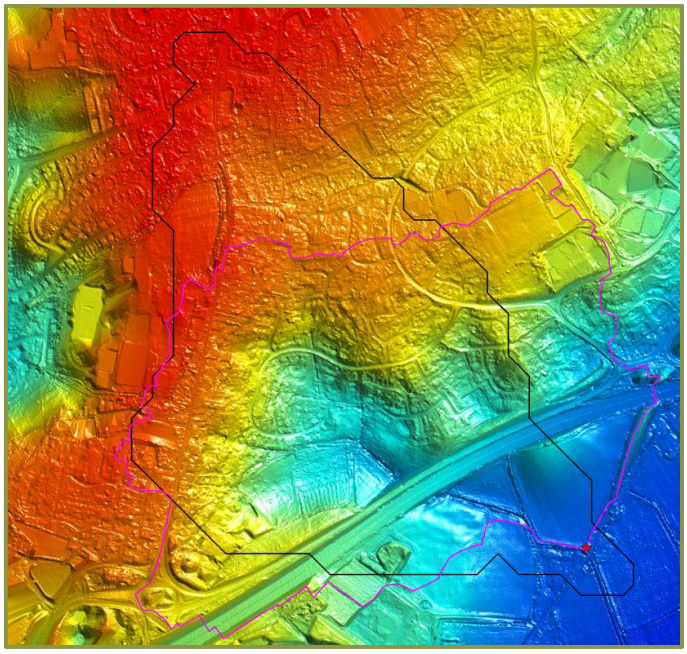
Catchment Boundary

2.1.2 The FEH Webservice catchment boundary at the model downstream extent of the model domain (NGR 474300,169100) is shown in Figure 2.1 and encompasses an area of 0.92km^2.

2.1.3 FEH Webservice catchment boundary has been checked against 1m DTM LiDAR data (as this is more detailed that the 50m grid resolution from the Integrated Hydrological Digital Terrain Model (IHDTM) used for the calculation of the FEH web service catchment boundaries), and OS mapping. It should always be ensured that the catchment be checked and accordingly adjusted to provide the most accurate assessment of catchment hydrology (Figures 2.1 to 2.3).

2.1.4 Based off a review of the catchment it was assessed that adjustment was required, resulting in an updated catchment area with a total area of 0.92km^2. This area is the same area in size when compared to the original catchment area.

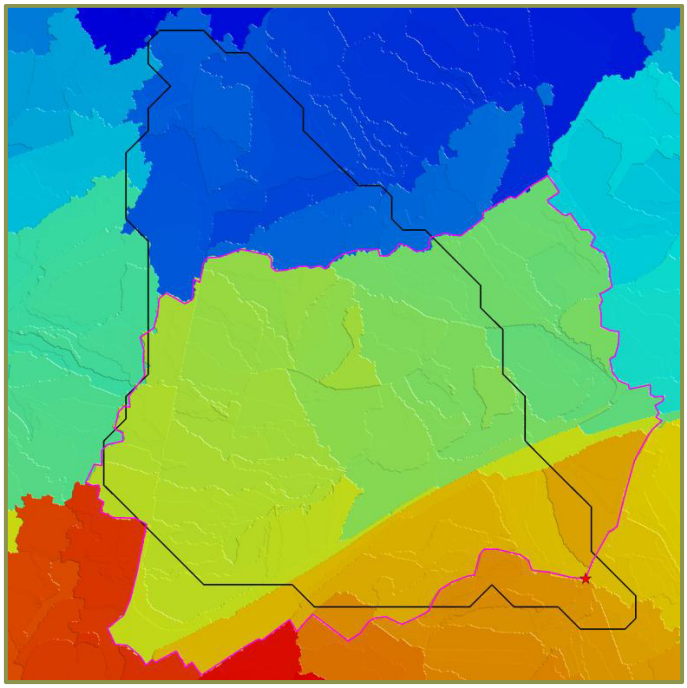
Figure 2.1: Catchment Boundaries and 2m DTM LiDAR Data



***Black**: FEH Webservice Catchment. **Pink**: Adjusted FEH Webservice Catchment. **Red Star:** Downstream Extent of Catchment.*

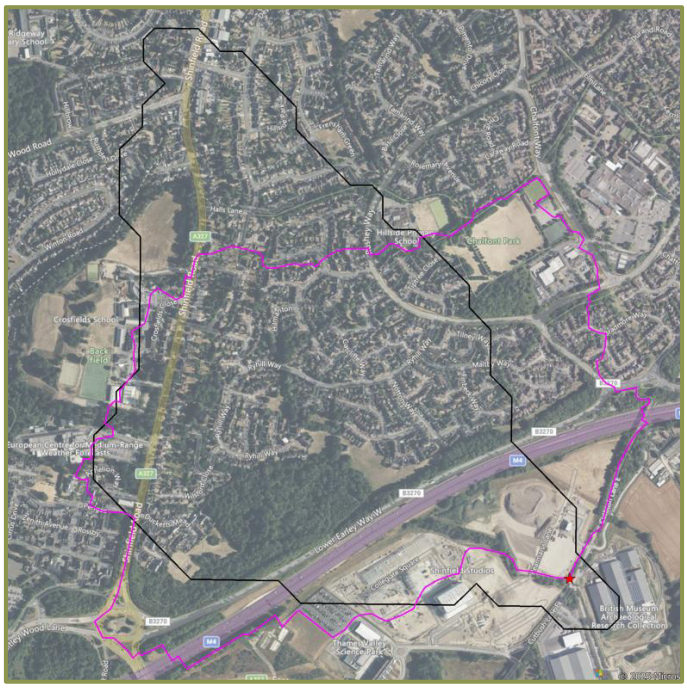
[1] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Figure 2.2: Catchment Boundaries and Watershed Analysis



***Black**: FEH Webservice Catchment. **Pink**: Adjusted FEH Webservice Catchment. **Red Star:** Downstream Extent of Catchment.*

Figure 2.3: Catchment Boundaries and Bing Mapping



***Black**: FEH Webservice Catchment. **Pink**: Adjusted FEH Webservice Catchment. **Red Star:** Downstream Extent of Catchment.*

Catchment Descriptors

2.1.5 Analysis of the FEH Webservice catchment descriptors (Table 2.1) for the 0.92 km^2 catchment was undertaken.

2.1.6 A discussion of the catchment descriptors downloaded from the FEH Webservice (Table 2.1), and how key catchment descriptors have been checked through a desktop study is provided below.

Table 2.1: Catchment Descriptors from the FEH Webservice Catchment

Catchment Descriptor	Value	Catchment Descriptor	Value
AREA	0.92 **(0.92)**	SPRHOST	44.82
ALTBAR	68	URBCONC1990	0.701
ASPBAR	126	URBEXT1990	0.2221
ASPVAR	0.70	URBLOC1990	1.136
BFIHOST	0.263	URBCONC2000	0.895
BFIHOST19	0.289	URBEXT2000	0.3311 **(0.42)**
DPLBAR	1.06	URBLOC2000	1.141
DPSBAR	39.2	C	-0.0298
FARL	1	D1	0.27508
FPEXT	0.0518	D2	0.27434
FPDBAR	0.256	D3	0.32557
FPLOC	0.55	E	0.30744
LDP	1.91	F	2.6041
PROPWET	0.29	C(1 km)	-0.029
RMED-1H	11.6	D1(1 km)	0.269
RMED-1D	29.9	D2(1 km)	0.269
RMED-2D	36.8	D3(1 km)	0.33
SAAR	642	E(1 km)	0.306
SAAR4170	650	F(1 km)	2.602

*Adjusted values are shown in **red***

BFIHOST/BFIHOST19

2.1.7 BFIHOST is the baseflow index developed using the Hydrology of Soil Types (HOST) classification and is the baseflow proportion of the flow on average. It is estimated based on daily mean flow data. Baseflow comprises water entering the watercourse through shallow subsurface flow and groundwater flow (mechanisms other than direct surface runoff); hence permeable soils and geology tend to yield a higher baseflow.

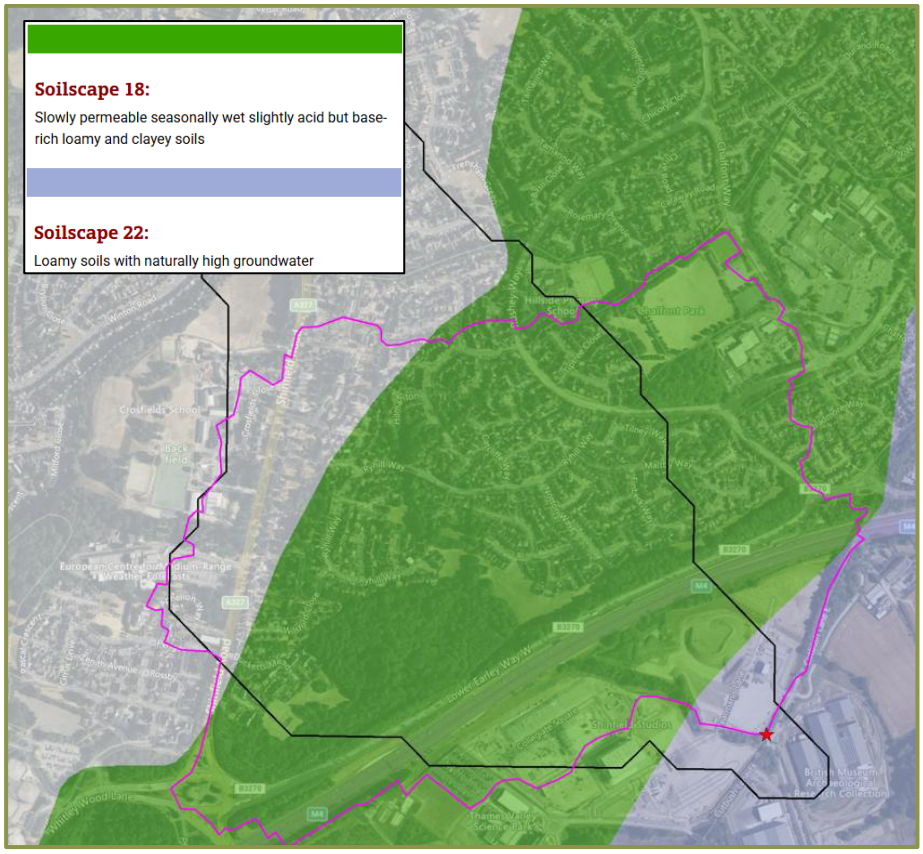
2.1.8 A new catchment descriptor called BFIHOST19 is now available in FEH Webservice datasets. BFIHOST19 addresses a number of issues associated with the original BFIHOST descriptor[2]

2.1.9 BFIHOST19 includes revised regression methods used to estimate BFIHOST and also has improved classification of rare soil types.

2.1.10 The catchment has been overlain the Cranfield Soil and Agrifood Institute Soilscapes mapping using the web mapping service function in MapInfo. The National Soils Resources Institute (Cranfield University) HOST mapping (Figure 2.4) was reviewed to verify the BFIHOST and BFIHOST19 value.

[2] https://fehweb.ceh.ac.uk/News/Article/bfihost19nowavailable

Figure 2.4: Soils Mapping



Soils Data © Cranfield University (NSRI) and for the Controller of HMSO [2025].

2.1.11 The standard values from the FEH Webservice for BFIHOST and BFIHOST19 will be carried forward as representative of the catchments.

SPRHOST

2.1.12 The SPRHOST parameter reflects the amount of surface runoff in a catchment and is also based on the HOST soils classifications. The SPRHOST value (44.82) reflects the loamy and clayey soils under laying the catchment.

2.1.13 SPRHOST was verified by a review of the HOST mapping. The standard values from the FEH Webservice are considered appropriate based on the desktop study of geological mapping and will be carried forward in this assessment.

PROPWET

2.1.14 PROPWET describes the proportion of time that soils are wet. PROPWET values for the UK range from approximately 0.80 in Northern Scotland where there is high annual rainfall, to 0.20 in East Anglia where annual rainfall is much lower.

2.1.15 Low PROPWET values tend to inhibit flooding, as the catchment is not saturated prior to a flood event and there is higher capacity for infiltration, the opposite is true for catchments with higher PROPWET values. The PROPWET values of 0.29 for the catchment is moderate and may be explained by the following factors:

- Wet spells only occur at a low frequency and tend to be of a relatively short duration (supported by the SAAR figures below).

- The catchment is in south England where rainfall levels are lower compared to the north and west. As stated above, low PROPWET values are representative of non-saturated catchments with high capacity for infiltration. The BFIHOST values, repressurising a permeable catchment, support the low PROPWET value.

2.1.16 The PROPWET values taken from the FEH Webservice is considered representative of the catchment.

FARL

2.1.17 The FARL value is a measure of flow attenuation caused by reservoirs and lakes, and ranges from 0 (total attenuation) to 1.0 (no discernible attenuation). The FARL value of 1 indicates no attenuation due to reservoirs or lakes. Scrutiny of OS mapping and the FEH webservice map did not highlight any waterbodies within the catchment.

2.1.18 The FARL value of 1 taken from the FEH Webservice data is therefore considered representative of the catchment.

URBEXT

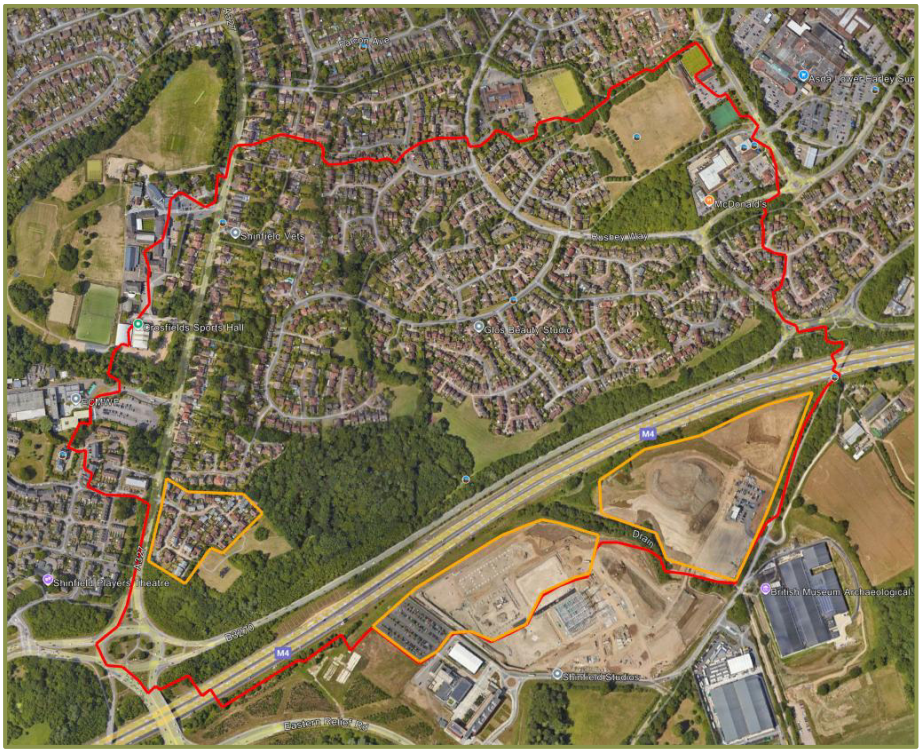
2.1.19 The Urban Extent URBEXT1990 output of 0.2221 indicates a 'heavily urbanised' catchment. The FEH catchment descriptor URBEXT2000 was calculated to be 0.3311, which also indicates a 'very heavily urbanised' catchment and shows urbanisation of the catchment in the intervening 10-year period. Urbanised areas include the Shinfield Studios development and residential development in the western extent of the catchment area.

2.1.20 In order to establish the 'new' URBEXT value for 2025, the existing catchment descriptors have been entered into ReFH2 and the urbanisation value altered on the urbanisation tab to update the existing URBEXT value (0.3311). The updated value of 0.42 (when accounting for the increase development areas shown in Figure 2.5) indicates a 'very heavily urbanised' catchment. This updated URBEXT values will be carried forward for the FEH statistical methodology and the RFeH2 methodology.

2.1.21 The urbanisation model in ReFH2 is based upon the basic urbanisation model by Kjeldsen[3].

[3] Kjeldsen, T.R., Miller, J.D., & Packman, J.C. 2013. Modelling design flood hydrographs in catchments with mixed urban and rural land cover. Hydrology Research, 44(6), 1040-1057.

Figure 2.5: 2025 Urbanised Areas



Red Line: *Adjusted Catchment Boundary* ***Orange Line:*** *Additional Urban Areas*

SAAR

2.1.22 SAAR values within the FEH represent standard average annual rainfall data for the standard period 1961-1990.

2.1.23 The catchment is in the south of England where rainfall levels are lower. Catchments in the south west of England are drier for a greater proportion of the time reflecting the decrease in reliable frontal rainfall and higher evapotranspiration rates.

2.1.24 A SAAR value of 642mm indicates a relatively dry catchment. Given the catchment locations within the south of England and at a relatively low altitude, the SAAR value taken from the FEH Webservice is considered representative and will be carried forward in this assessment.

DPSBAR

2.1.25 The Drainage Path Slope (DPSBAR) shows a value of 39.2, which indicates a moderately steep catchment. This is supported by a review of OS mapping and LiDAR. The DPSBAR value taken from the FEH Webservice is considered representative of the catchment.

2.1.26 The FEH Webservice DPSBAR values of 39.2 is considered representative.

2.2 FEH Statistical Method (Adjusted Catchment)

Introduction

2.2.1 To determine the most appropriate hydrological methodology for the adjusted catchment, the peak flood flows from FEH Statistical and ReFH2 methodologies were assessed for the Adjusted Catchment, inclusive of adjustments to BFIHOST, SPRHOST and AREA.

2.2.2 Following the FEH Statistical and ReFH2 assessments, justification will be provided for the carry forward method to be utilised for peak flow assessments for the compartmentalised catchment.

2.2.3 The FEH Statistical Method is based on an Index Flood, which is the median annual maximum flood from Catchment Descriptors and then improving this using data from an appropriate Gauging Station (if available). This reduces the error associated with the estimation of QMED using only Catchment Descriptors. QMED is formally defined as the middle-ranking value in the series of annual maximum floods, where the annual maximum series comprises, the largest flow observed in each year. QMED is the flood that is exceeded on average "every other year" and can therefore loosely be attributed a return period of 1 in 2-years.

QMED Estimation using Donor Stations

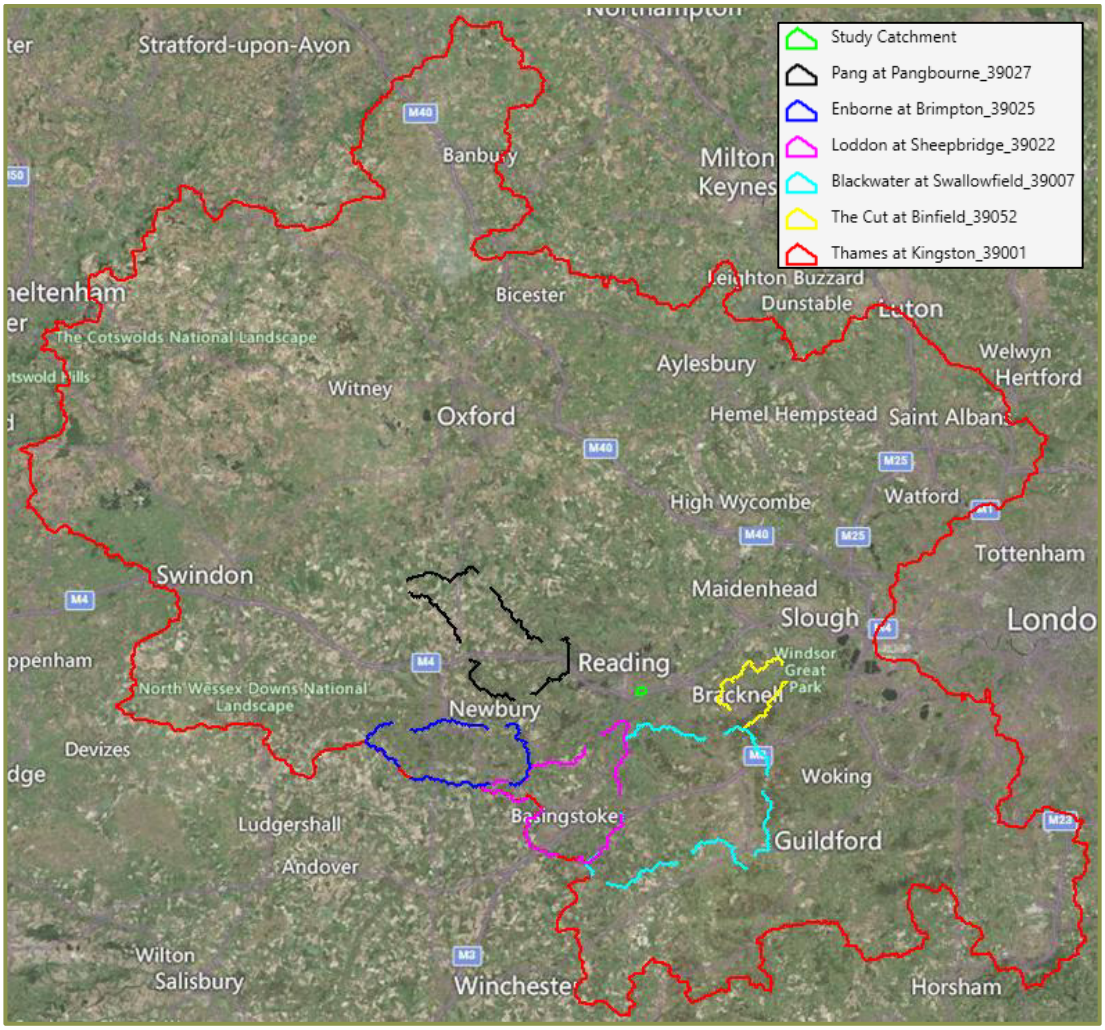
2.2.4 The study catchment is not directly gauged at the catchment outlet (or upstream/downstream of the adjusted catchment); however, WINFAP-FEH v5 identified the following gauging stations as being suitable for QMED estimation.

- **39052 – The Cut at Binfield**: The station has a catchment area of 49.99km^2 and is listed as being suitable for QMED [4], with a 66-year record.
- **39007 – Blackwater at Swallowfield**: The station has a catchment area of 359.81km^2 and is listed as being suitable for QMED [5], with a 70-year record.
- **39022 – Loddon at Sheepbridge**: The station has a catchment area of 176.77km^2 and is listed as being suitable for QMED [6], with a 58-year record.
- **39001 – Thames at Kingston**: The station has a catchment area of 9930.79km^2 and is listed as being suitable for QMED [7], with a 140-year record.
- **39027 – Pang at Pangbourne**: The station has a catchment area of 175.68km^2 and is listed as being suitable for QMED [8], with a 55-year record.
- **39025 – Enborne at Brimpton**: The station has a catchment area of 142.01km^2 and is listed as being suitable for QMED [9], with a 56-year record.

2.2.5 The study catchment and its proximity to those listed above are shown in Figure 2.6.

[4] https://nrfa.ceh.ac.uk/data/station/info/39052
[5] https://nrfa.ceh.ac.uk/data/station/info/39007
[6] https://nrfa.ceh.ac.uk/data/station/info/39022
[7] https://nrfa.ceh.ac.uk/data/station/info/39001
[8] https://nrfa.ceh.ac.uk/data/station/info/39027
[9] https://nrfa.ceh.ac.uk/data/station/info/39025

Figure 2.6: Gauging Station Catchment Location Comparisons



2.2.6 A comparison of key catchment descriptors for the study catchment against the gauging stations that are deemed suitable for QMED estimation (obtained from the NRFA webpage[10]) are presented in Tables 2.2 to 2.7.

Table 2.2: Catchment Descriptor Comparison – The Cut at Binfield

Catchment Descriptor	Study Catchment Descriptors	The Cut at Binfield Gauging Station
AREA	0.92 **(0.92)**	50.20
BFIHOST	0.263	0.355
BFIHOST19	0.289	0.366
FARL	1	0.939
PROPWET	0.29	0.29
SAAR	642	688
SPRHOST	44.82	41.54
URBEXT2000	0.3311 **(0.42)**	0.2374

*Adjusted values are shown in **red***

[10] https://nrfa.ceh.ac.uk/data/station/peakflow/44015

Table 2.3: Catchment Descriptor Comparison – Blackwater at Swallowfield

Catchment Descriptor	Study Catchment Descriptors	Blackwater at Swallowfield Gauging Station
AREA	0.92 **(0.92)**	354.80
BFIHOST	0.263	0.630
BFIHOST19	0.289	0.674
FARL	1	0.886
PROPWET	0.29	0.32
SAAR	642	712
SPRHOST	44.82	26.79
URBEXT2000	0.3311 **(0.42)**	0.1323

*Adjusted values are shown in **red***

Table 2.4: Catchment Descriptor Comparison – Loddon at Sheepbridge

Catchment Descriptor	Study Catchment Descriptors	Loddon at Sheepbridge Gauging Station
AREA	0.92 **(0.92)**	164.50
BFIHOST	0.263	0.594
BFIHOST19	0.289	0.664
FARL	1	0.947
PROPWET	0.29	0.33
SAAR	642	757
SPRHOST	44.82	26.40
URBEXT2000	0.3311 **(0.42)**	0.0872

*Adjusted values are shown in **red***

Table 2.5: Catchment Descriptor Comparison – Thames at Kingston

Catchment Descriptor	Study Catchment Descriptors	Thames at Kingston Gauging Station
AREA	0.92 **(0.92)**	9948.00
BFIHOST	0.263	0.653
BFIHOST19	0.289	0.679
FARL	1	0.942
PROPWET	0.29	0.30
SAAR	642	724
SPRHOST	44.82	26.94
URBEXT2000	0.3311 **(0.42)**	0.0664

*Adjusted values are shown in **red***

Table 2.6: Catchment Descriptor Comparison – Pang at Pangbourne

Catchment Descriptor	Study Catchment Descriptors	Pang at Pangbourne Gauging Station
AREA	0.92 **(0.92)**	170.90
BFIHOST	0.263	0.720
BFIHOST19	0.289	0.782
FARL	1	0.996
PROPWET	0.29	0.31

Catchment Descriptor	Study Catchment Descriptors	Pang at Pangbourne Gauging Station
SAAR	642	702
SPRHOST	44.82	22.04
URBEXT2000	0.3311 **(0.42)**	0.0118

*Adjusted values are shown in **red***

Table 2.7: Catchment Descriptor Comparison – Enborne at Brimpton

Catchment Descriptor	Study Catchment Descriptors	Enborne at Brimpton Gauging Station
AREA	0.92 **(0.92)**	147.60
BFIHOST	0.263	0.500
BFIHOST19	0.289	0.563
FARL	1	0.978
PROPWET	0.29	0.32
SAAR	642	794
SPRHOST	44.82	32.78
URBEXT2000	0.3311 **(0.42)**	0.0199

*Adjusted values are shown in **red***

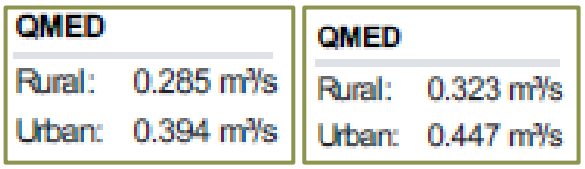
2.2.7 FEH statistical software provided a number of additional donor stations to consider for the flow calculations for the catchment. All stations are listed below with reasons for acceptance or refusal also detailed:

- 39052 – The Cut at Binfield – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39007 – Blackwater at Swallowfield – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39022 – Loddon at Sheepbridge – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39001 – Thames at Kingston – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39027 – Pang at Pangbourne – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39025 – Enborne at Brimpton – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39023 – Wye at Bourne End Hedsor – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39033 – Winterbourne Stream at Bagnor – **Rejected**. Removed as URBEXT2000 value is not comparable.
- 42009 – Candover Stream at Borough Bridge – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.
- 39011 – Wey at Tilford – **Rejected**. Removed as FARL and URBEXT2000 values are not comparable.

QMED Comparison

2.2.8 Figure 2.7 shows the comparison for QMED from donor stations and catchment descriptors for the catchment. It can be seen that for the catchment, QMED from catchment descriptors is 12.5% greater than from donor stations.

Figure 2.7: QMED Comparison



Top Left: *Donor Station QMED* ***Top Right:*** *Catchment Descriptors QMED*

QMED Choice Going Forwards

2.2.9 Based on the above QMED and flows for the catchment will be derived from catchment descriptors.

Pooling Group Analysis

2.2.10 The pooling group analysis and QMED estimation (based on catchment descriptors) is described below. WINFAP FEH v5 software (Version 5.2.9046 [25885]) and the NRFA Peak Flow v13.0.2 dataset was used the undertake the assessment. Outputs from FEH statistical can be viewed in Appendix 1.

2.2.11 To estimate the magnitude of the statistical flood events occurring within the ungauged (adjusted) catchment, it is necessary to determine a flood growth curve and a flood frequency curve. This is done by forming a pooling group, which is a group of hydrologically similar catchments across the UK which have gauged records covering a statistically adequate number of years to obtain reliable flood estimates and subjecting this group to statistical analysis.

2.2.12 To calculate reliable flood estimates, the FEH recommends that a pooling group should contain five times as many station-years as the target return period (5T) however, the 'Improved Statistical Method' (2008) recommends that a fixed pooling group size of at least 500 annual maxima events should be used for all return period events. This revised advice has been adopted in this instance.

2.2.13 The FEH Webservice catchment descriptors in Table 2.1 were imported into the WINFAP-FEH v5 and a pooling group with 529 years of data was created (Figure 2.8).

2.2.14 It should be noted that URBEXT has been applied as per default to the pooling groups, as per available Environment Agency guidance. With the default Urban Adjustment Factor (UAF) being applied as per that calculated in the FEH statistical software. The urban adjustment procedures in WINFAP are based on those published by Kjeldsen11 (2010).

2.2.15 The initial pooling group was identified as 'possibly heterogenous' and a review of the pooling group is 'optional'.

[11] Kjeldsen, T.R. 2010. Modelling the impact of urbanization on flood frequency relationships in the UK. Hydrology Research, Volume 41, Issue 5, 391-405

Figure 2.8: Initial Pooling Group

Pooling group AM data							
Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	1.320	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	3.081	30	3.352	0.288	**0.289**	0.408	**0.407**
27051 (Crimple @ Burn Bridge)	3.131	51	4.564	0.217	**0.217**	0.142	**0.141**
28033 (Dove @ Hollinsclough)	3.361	48	4.138	0.235	**0.235**	0.367	**0.367**
23018 (Ouse Burn @ Woolsington)	3.472	32	3.287	0.273	**0.290**	0.192	**0.175**
27073 (Brompton Beck @ Snainton Ings)	3.681	43	0.812	0.212	**0.213**	0.033	**0.032**
91802 (Allt Leachdach @ Intake)	3.842	34	6.350	0.153	**0.153**	0.257	**0.257**
25019 (Leven @ Easby)	3.956	45	5.090	0.341	**0.342**	0.373	**0.372**
26016 (Gypsey Race @ Kirby Grindalythe)	3.998	26	0.100	0.318	**0.318**	0.253	**0.253**
71003 (Croasdale Beck @ Croasdale Flume)	4.019	37	10.900	0.212	**0.212**	0.323	**0.323**
25011 (Langdon Beck @ Langdon)	4.025	37	15.647	0.225	**0.225**	0.321	**0.321**
92002 (Allt Coire nan Con @ Polloch)	4.053	22	13.573	0.122	**0.122**	0.320	**0.320**
47022 (Tory Brook @ Newnham Park)	4.063	28	6.134	0.243	**0.245**	0.163	**0.160**
25003 (Trout Beck @ Moor House)	4.087	50	15.182	0.170	**0.170**	0.299	**0.299**
Total		**529**					

2.2.16 A review of the pooling group was undertaken starting with the stations with the highest discordancy. Station flow data, gauging method/type, catchment descriptions and photos provided on the NRFA website were assessed for each station.

2.2.17 The reviewed/final pooling group for the catchment can be viewed in Figure 2.9.

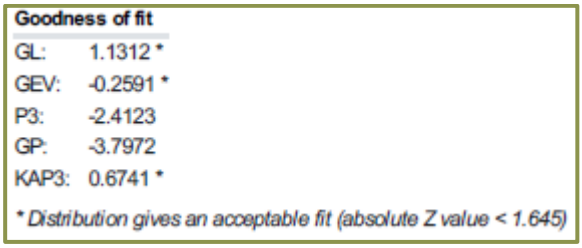
Figure 2.9: Reviewed Pooling Group

Pooling group AM data							
Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	1.320	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	3.081	30	3.352	0.288	**0.289**	0.408	**0.407**
27051 (Crimple @ Burn Bridge)	3.131	51	4.564	0.217	**0.217**	0.142	**0.141**
28033 (Dove @ Hollinsclough)	3.361	48	4.138	0.235	**0.235**	0.367	**0.367**
23018 (Ouse Burn @ Woolsington)	3.472	32	3.287	0.273	**0.290**	0.192	**0.175**
27073 (Brompton Beck @ Snainton Ings)	3.681	43	0.812	0.212	**0.213**	0.033	**0.032**
91802 (Allt Leachdach @ Intake)	3.842	34	6.350	0.153	**0.153**	0.257	**0.257**
25019 (Leven @ Easby)	3.956	45	5.090	0.341	**0.342**	0.373	**0.372**
26016 (Gypsey Race @ Kirby Grindalythe)	3.998	26	0.100	0.318	**0.318**	0.253	**0.253**
71003 (Croasdale Beck @ Croasdale Flume)	4.019	37	10.900	0.212	**0.212**	0.323	**0.323**
25011 (Langdon Beck @ Langdon)	4.025	37	15.647	0.225	**0.225**	0.321	**0.321**
92002 (Allt Coire nan Con @ Polloch)	4.053	22	13.573	0.122	**0.122**	0.320	**0.320**
47022 (Tory Brook @ Newnham Park)	4.063	28	6.134	0.243	**0.245**	0.163	**0.160**
25003 (Trout Beck @ Moor House)	4.087	50	15.182	0.170	**0.170**	0.299	**0.299**
Total		**529**					

2.2.18 Following the review, the pooling group is 'possibly heterogenous' and a review of the pooling group is 'optional'. However, no further reasons for station removal or addition were found. As such, the reviewed pooling group (Figure 2.9) has been carried forward with no further reviews.

2.2.19 Generalised Logistic (GL), Generalised Extreme Value (GEV), Pearson Type III (PTIII), and Generalised Pareto (GP) fittings were used to determine goodness of fit (Figure 2.10).

Figure 2.10: Goodness of Fit



2.2.20 The FEH recommends the (GL) distribution as the most suitable for fitting pooled growth curves to UK flood data and this recommendation has been adhered to in this assessment. The results can vary slightly, depending on the chosen distribution for the statistical analysis. The Pooling Group growth curve fittings and flood frequency curve fittings are included below in Table 2.8.

Table 2.8: Pooled Group Growth Fittings and Flood Frequency

Return period	Growth Fittings	Peak Flow (m^3/s)
2	1.000	0.44
5	1.284	0.57
10	1.525	0.68
30	2.016	0.90
50	2.309	1.03
100	2.795	1.24
200	3.408	1.52
1000	5.542	2.47

2.3 ReFH2 Method

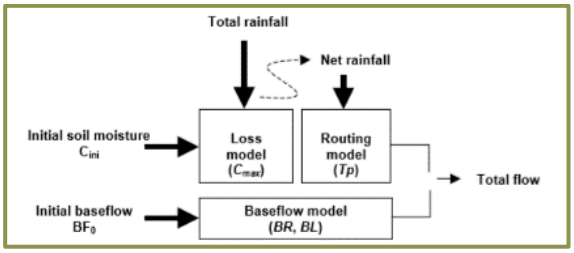
Introduction

2.3.1 The Revitalised Rainfall-runoff (ReFH) model was first published in 2005 as an update to the previous FEH rainfall-runoff method, the FSR/FEH rainfall-runoff method. ReFH was based on robust hydrological modelling techniques and was an improvement over the FEH/FSR Rainfall Runoff method (FEH), as described in the FEH. The method uses catchment descriptors from the FEH Webservice, to generate design flood events of specific return periods.

2.3.2 ReFH2 was released in early 2015, with a significant update (Version 2.1), published in November 2015. ReFH2 includes an extension of the ReFH model to represent urban catchments and is compatible with FEH2022 rainfall frequency statistics.

2.3.3 The ReFH model has three components: a loss model (Cmax), a routing model (Tp) and a base flow model (BR, BL) (Table 2.9). The loss model uses a soil moisture accounting approach to define the amount of rainfall occurring over the catchment that is converted to direct runoff. The rainfall losses are derived as the event unfolds, rather than being defined by a fixed value of percentage runoff. The routing component of ReFH uses the unit hydrograph concept, adopting a 'kinked' triangle as the standard shape. Finally, the base flow model is based on the linear reservoir concept with its characteristic recession defined by an exponential decay controlled by the recession constant termed base flow lag (Figure 2.11).

Figure 2.11: Schematic Representation of the ReFH Model



Source: Wallingford HydroSolutions Ltd 2016. The Revitalised Flood Hydrograph Model ReFH2.2: Technical Guidance.

Table 2.9: Summary of the Six ReFH Model Parameters

Name	Parameter or Initial Condition	Description
T_p	Model parameter	Unit hydrograph time to peak (hours)
B_L	Model parameter	Baseflow recession constant or lag (hours)
B_R	Model parameter	Baseflow recharge
C_{Max}	Model parameter	Maximum soil moisture capacity (mm)
C_{ini}	Initial condition	Initial moisture content (mm)
BF_0	Initial condition	Initial baseflow (m^3s^{-1})

Source: Wallingford HydroSolutions Ltd 2016. The Revitalised Flood Hydrograph Model ReFH2.2: Technical Guidance.

2.3.4 The ReFH2 calculations were undertaken within the ReFH2 standalone software to calculate peak flow estimates from catchment descriptors as provided in Table 2.1. The default rainfall parameters derived by the FEH 2022 rainfall model were applied for the catchment. Calculation extracts for events run through the ReFH2 methodology are included in Appendix 2.

Storm Duration Estimation

2.3.5 A storm duration of 4.50 hours and a timestep of 0.50 hours were used. A Seasonal Correction Factor (SCF) of 0.99 and Areal Reduction Factor (ARF) of 0.98 were also applied.

Peak Flow Estimation

2.3.6 In line with ReFH2 Method guidance, a summer seasonality (default storm profile) was selected, and flows were estimated for each required return period.

2.3.7 The default analysis for storm seasonality is as follows:

- Summer storms are selected by default if:
  - URBEXT2000 is ≥ 0.30, or
  - 0.15 ≤ URBEXT2000 < 0.30 and BFIHOST19 is ≥ 0.65.
- Winter storms are selected by default in all other cases.

2.3.8 The model parameters for the ReFH2 method should ideally be based on actual flood event data comprising rainfall and flow records rather than catchment descriptors alone. However, due to the lack of available flow data for the catchment, the ReFH2 design standards have been adopted in this instance based on the technical guidance. The key ReFH2 model

parameter values are provided in Table 2.10. The peak flows calculated using the ReFH2 Method are summarised in Table 2.11.

Table 2.10: ReFH2 Parameters

Parameter	Unit	Default Value	Adjusted Value
T_p	Hours (hrs)	2.53	-
B_L	Hours (hrs)	26.05	-
B_R	-	0.55	-
C_{Max}	Millimetres (mm)	244.17	-
C_{ini}	Millimetres (mm)	109.62	-
BF_0	m^3/s	0.03	-

Table 2.11: ReFH2 Method Peak Flows (Summer Profile)

Return Period	Peak Flow (m^3/s)
2	0.80
5	1.20
10	1.48
30	1.95
50	2.18
100	2.53
200	2.91
1000	4.11

Summary of Results

2.3.9 Table 2.12 summarise the findings of the two hydrological methodologies. Figure 2.12 details a comparison of FEH statistical and ReFH2 flows, alongside the hydrographs for the ReFH2 calculations, which will be scaled to FEH statistical peak flows where appropriate (full ReFH2 hydrographs can viewed in Appendix 3).

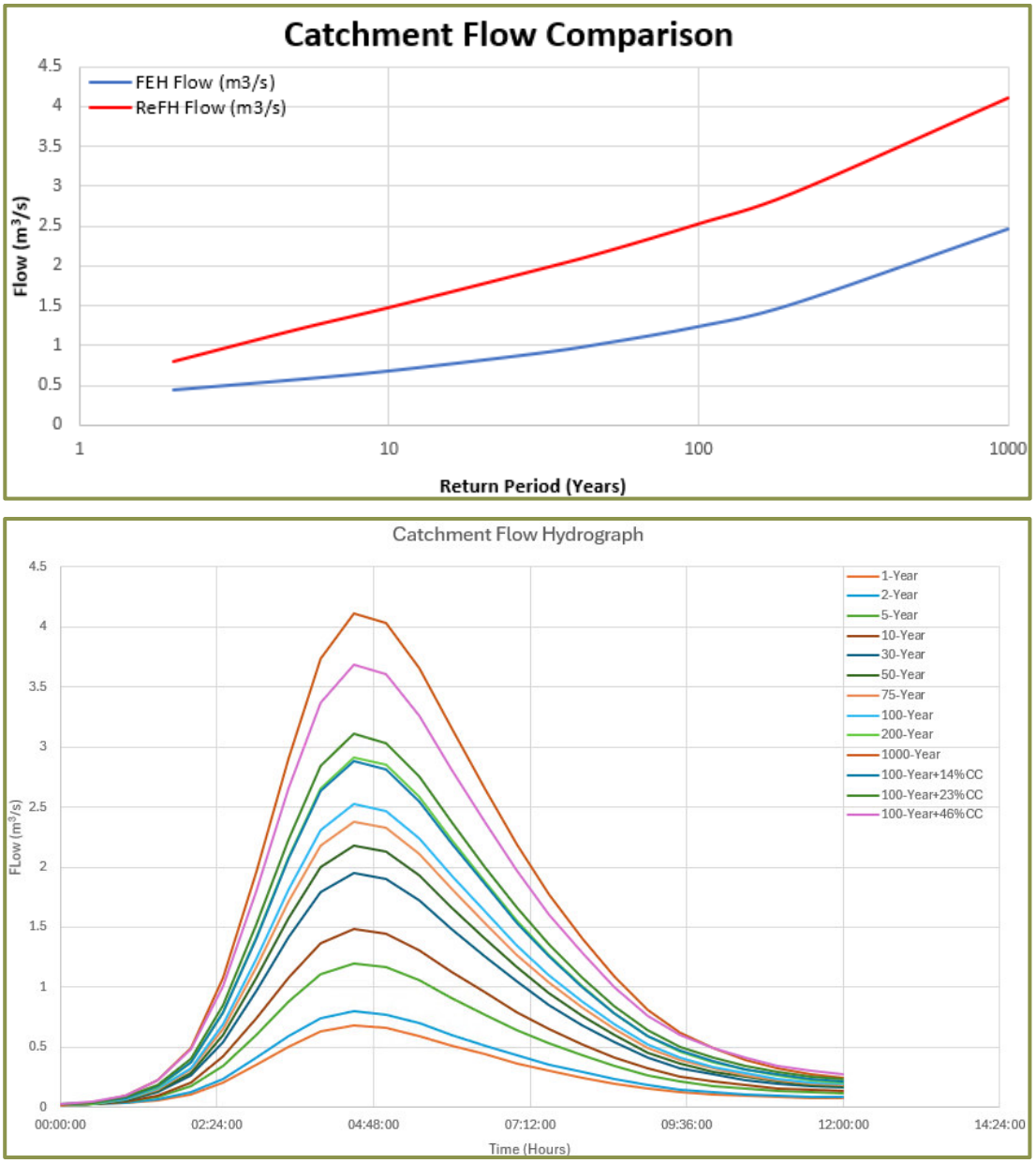
Table 2.12: Summary of Results

Return Period	FEH Statistical method (Pooled Group Analysis – Adjusted QMED)	ReFH2 Method (m^3/s)	Percentage Variation
2	0.44	0.80	58
5	0.57	1.20	71
10	0.68	1.48	74
30	0.90	1.95	74
50	1.03	2.18	72
100	1.24	2.53	68
200	1.52	2.91	63
1000	2.47	4.11	50
*100+14%CC	1.41	2.88	69
*100+23%CC	1.52	3.11	69
*100+46%CC	1.81	3.69	69

** Loddon and tributaries Management Catchment 14% ('Central' estimate), 23% ('Higher Central' estimate) and 46% ('Upper End' estimate) for the Total Potential Change anticipated by the 2080's[12]*

[12] https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow

Figure 2.12: Graph Summary of Results



2.4 Limitations

2.4.1 The following limitations are associated with this study:

- Pooling groups are representative of study catchments.
- Catchments included in pooling groups are statistically homogeneous so that their (standardised) AMAX flows can be fitted by a single distribution. For pooling group analysis undertaken for permeable catchments, a number of stations included in the pooling group were less permeable and therefore may differ in their flood generating characteristics.
- There is no catchment flow data for Stoke Water to verify the peak flow estimates generated by this assessment.

2.4.2 The design peak flow estimates and hydrographs have been derived for the purposes of this modelling study. If peak flow estimates and hydrographs are required for different purposes it is recommended that, at a minimum, a review of the results is carried out and any recent flow data incorporated into the calculations.

2.5 Analysis of Peak Flow and Choice Going Forward

Analysis of Peak Flow

2.5.1 It is expected that results using the different methods will vary. In urban catchments, the ReFH2 method normally gives larger estimates than the FEH Statistical (Pooled Group) method, which typically underestimates peak flows. The hydrological calculations show that ReFH2 peak flows are between 58% to 74% greater than those derived from for all FEH statistical return events.

2.5.2 Below is a summary of the advantages and disadvantages associated with each of the methodologies.

FEH Statistical Method

2.5.3 Below is a summary of the advantages to using the Statistical Method within this study's catchments:

- The method is based on a larger dataset than the ReFH2 method.
- Has undergone more direct calibration to reproduce flood frequency in the UK than the other methods.
- As per Section 6.6 of the Flood Estimation Guidelines[13] document all flood estimates for extreme return periods rely, however indirectly, on extrapolation. For this reason, given the typical length of flood peak records, the FEH statistical method was originally recommended principally for return periods up to 200 years. As such, the 1000-year flows will be derived from ReFH2 outputs.

2.5.4 Below is a summary of the disadvantages to using the Statistical Method within this study's catchments:

- The catchment is less than 1000km^2, therefore the Statistical Method has no advantage over the ReFH2 method.

ReFH2 Method

2.5.5 Below is a summary of the advantages to using the ReFH2 Method within this study catchment:

- The ReFH2 method is based on Catchment Descriptors specific to the study catchment, with Catchment Descriptors being verified or updated (i.e. AREA, and URBEXT updated to URBEXT2019).
- There are no continuous flow records as the study area is not directly gauged, and there are no gauges located within the vicinity of the study area.
- The return period is long, for example 1000 years.

[13] LIT11832: Flood Estimation Guidelines, Environment Agency. (23/12/2022).

Choice Going Forward

2.5.6 The flows to be used in the model are shown in Table 2.13.

Table 2.13: Summary of Results

Return Period	Input Flows (m^3/s)
30	1.95
100	2.53
1000	4.11
*100+14%CC	2.88
*100+23%CC	3.11
*100+46%CC	3.69

** Loddon and tributaries Management Catchment 14% ('Central' estimate), 23% ('Higher Central' estimate) and 46% ('Upper End' estimate) for the Total Potential Change anticipated by the 2080's[14]. Climate change allowances for peak flows have been obtained by adding an uplift to the 100-year peak flow.*

2.5.7 As stated within the Flood Estimation Guidelines (LIT 11832) produced by the Environment Agency (December 2022):

"*By its very nature, flood estimation is an uncertain science, and this uncertainty is probably greater than many hydrologists realise. Even many weeks of work won't produce a definitive statement on the magnitude of a 1% probability flood or the rarity of an observed event. These guidelines offer advice on identifying sources of uncertainty. They provide methods for calculating confidence limits for flood estimates derived using standard FEH methods*."

2.5.8 As such, the methods used within this report are deemed to be the most suitable at the time the document was completed and deemed to be appropriate for the study that is being undertaken.

[14] https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow

APPENDICES

Appendix 1 - FEH Statistical Outputs

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	01-04-2025 11:18:13
Software:	WINFAP Version: 5.2.9046 (25885)
Peak Flow dataset:	Peak Flow Dataset 13.0.2
Supplementary data used:	No

Site details

Site number:	4105410641
Site name:	Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1
Site location:	SU 74300 69100
Easting:	474300
Northing:	169100
Catchment area:	0.92 km²
SAAR:	642 mm
BFIHOST19:	0.289
FPEXT:	0.052
FARL:	1.000
URBEXT2000:	0.4200

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.61 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.38229

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.420
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Catchment Descriptors

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	1.320	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	3.081	30	3.352	0.288	**0.289**	0.408	**0.407**
27051 (Crimple @ Burn Bridge)	3.131	51	4.564	0.217	**0.217**	0.142	**0.141**
28033 (Dove @ Hollinsclough)	3.361	48	4.138	0.235	**0.235**	0.367	**0.367**
23018 (Ouse Burn @ Woolsington)	3.472	32	3.287	0.273	**0.290**	0.192	**0.175**
27073 (Brompton Beck @ Snainton Ings)	3.681	43	0.812	0.212	**0.213**	0.033	**0.032**
91802 (Allt Leachdach @ Intake)	3.842	34	6.350	0.153	**0.153**	0.257	**0.257**
25019 (Leven @ Easby)	3.956	45	5.090	0.341	**0.342**	0.373	**0.372**
26016 (Gypsey Race @ Kirby Grindalythe)	3.998	26	0.100	0.318	**0.318**	0.253	**0.253**
71003 (Croasdale Beck @ Croasdale Flume)	4.019	37	10.900	0.212	**0.212**	0.323	**0.323**
25011 (Langdon Beck @ Langdon)	4.025	37	15.647	0.225	**0.225**	0.321	**0.321**
92002 (Allt Coire nan Con @ Polloch)	4.053	22	13.573	0.122	**0.122**	0.320	**0.320**
47022 (Tory Brook @ Newnham Park)	4.063	28	6.134	0.243	**0.245**	0.163	**0.160**
25003 (Trout Beck @ Moor House)	4.087	50	15.182	0.170	**0.170**	0.299	**0.299**
Total		**529**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
76011 (Coal Burn @ Coalburn)	Yes	Yes	46	0	0.00			1.004	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.079	
27051 (Crimple @ Burn Bridge)	Yes	Yes	51	3	5.88	1.34	None	0.575	
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			0.886	
23018 (Ouse Burn @ Woolsington)	Yes	Yes	32	4	12.50	0.70	None	0.899	
27073 (Brompton Beck @ Snainton Ings)	Yes	Yes	43	2	4.65	0.92	None	1.880	
91802 (Allt Leachdach @ Intake)	Yes	Yes	34	0	0.00	-0.42	None	0.505	
25019 (Leven @ Easby)	Yes	Yes	45	3	6.67			1.419	
26016 (Gypsey Race @ Kirby Grindalythe)	Yes	Yes	26	4	15.38			0.820	
71003 (Croasdale Beck @ Croasdale Flume)	Yes	Yes	37	1	2.70			0.392	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			1.431	
92002 (Allt Coire nan Con @ Polloch)	Yes	Yes	22	0	0.00			1.512	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			1.211	
25003 (Trout Beck @ Moor House)	Yes	Yes	50	1	2.00			0.386	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
76011 (Coal Burn @ Coalburn)	1.630	1096	0.074	1.000	0.000	0.274
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
27051 (Crimple @ Burn Bridge)	8.172	855	0.013	1.000	0.006	0.329
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
23018 (Ouse Burn @ Woolsington)	10.137	670	0.131	0.977	0.100	0.333
27073 (Brompton Beck @ Snainton Ings)	8.060	721	0.237	1.000	0.008	0.811
91802 (Allt Leachdach @ Intake)	6.522	2555	0.003	0.992	0.000	0.277
25019 (Leven @ Easby)	15.088	830	0.019	1.000	0.004	0.495
26016 (Gypsey Race @ Kirby Grindalythe)	15.850	757	0.030	1.000	0.000	0.927
71003 (Croasdale Beck @ Croasdale Flume)	10.710	1882	0.016	1.000	0.000	0.283
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
92002 (Allt Coire nan Con @ Polloch)	8.148	2538	0.009	0.989	0.000	0.261
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
25003 (Trout Beck @ Moor House)	11.395	1905	0.041	1.000	0.000	0.255

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.227	Urban L-CV:	0.177
Rural L-Skewness:	0.266	Urban L-Skewness:	0.344

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.223	-0.266		0.160
GEV	0.882	0.314	-0.144		-1.305
KAP3	0.939	0.263	-0.211	-0.400	-0.307

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.160	-0.344		0.536
GEV	0.919	0.211	-0.254		0.090
KAP3	0.958	0.182	-0.305	-0.400	0.360

Goodness of fit

GL:	1.1312 *
GEV:	-0.2591 *
P3:	-2.4123
GP:	-3.7972
KAP3:	0.6741 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 1.7959

The pooling group is possibly heterogeneous and a review of the pooling group is optional.

Standardised growth curves

Rural

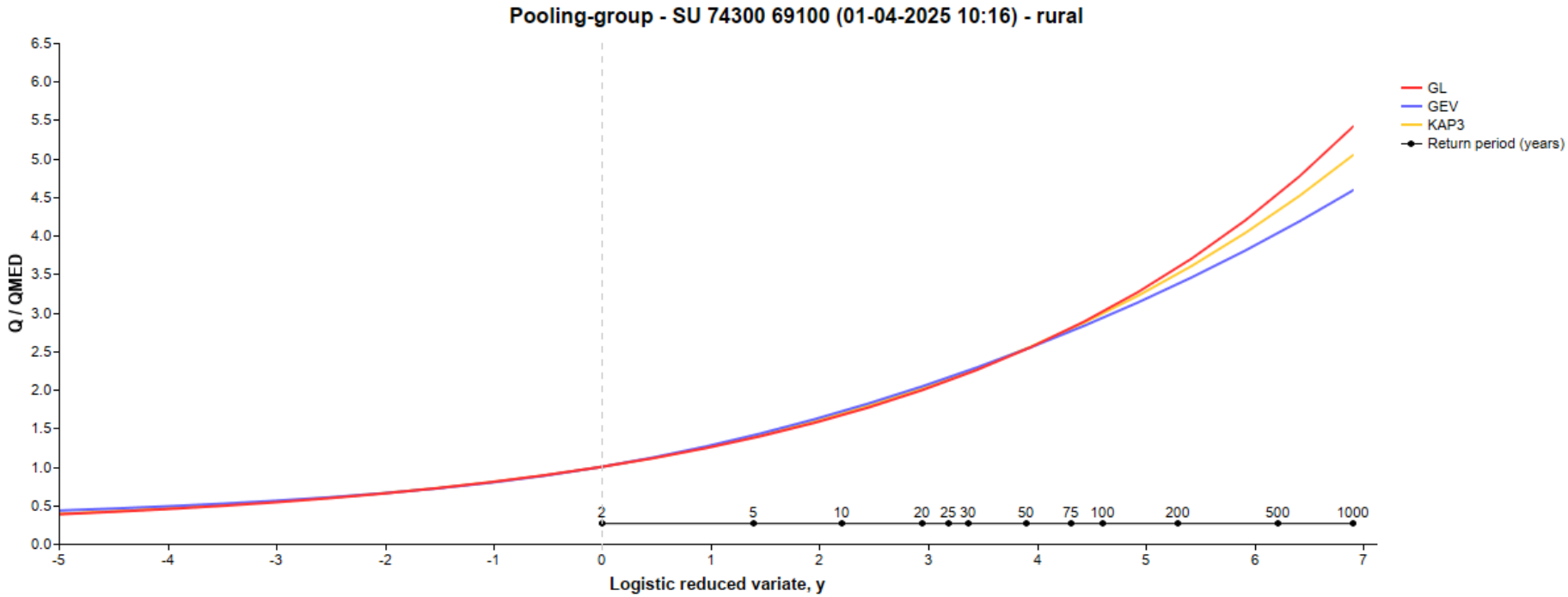
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.374	1.407	1.388
10	1.665	1.716	1.688
20	1.996	2.045	2.021
25	2.113	2.156	2.137
30	2.214	2.250	2.235
50	2.521	2.524	2.531
75	2.794	2.756	2.787
100	3.006	2.928	2.982
200	3.586	3.372	3.503
500	4.533	4.031	4.318
1000	5.418	4.590	5.047

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.284	1.304	1.292
10	1.525	1.560	1.540
20	1.815	1.855	1.834
25	1.922	1.961	1.942
30	2.016	2.052	2.035
50	2.309	2.328	2.323
75	2.579	2.573	2.584
100	2.795	2.763	2.790
200	3.408	3.281	3.365
500	4.478	4.120	4.337
1000	5.542	4.898	5.275

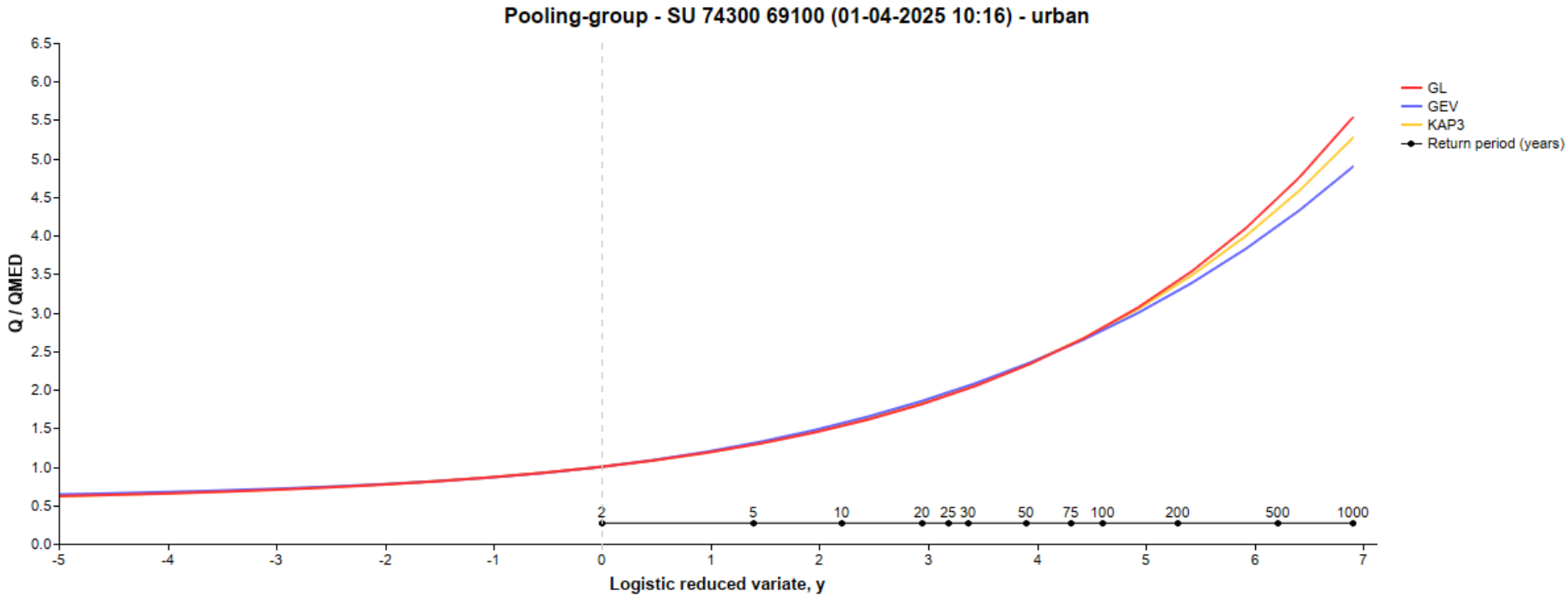
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

QMED	
Rural:	0.323 m³/s
Urban:	0.447 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

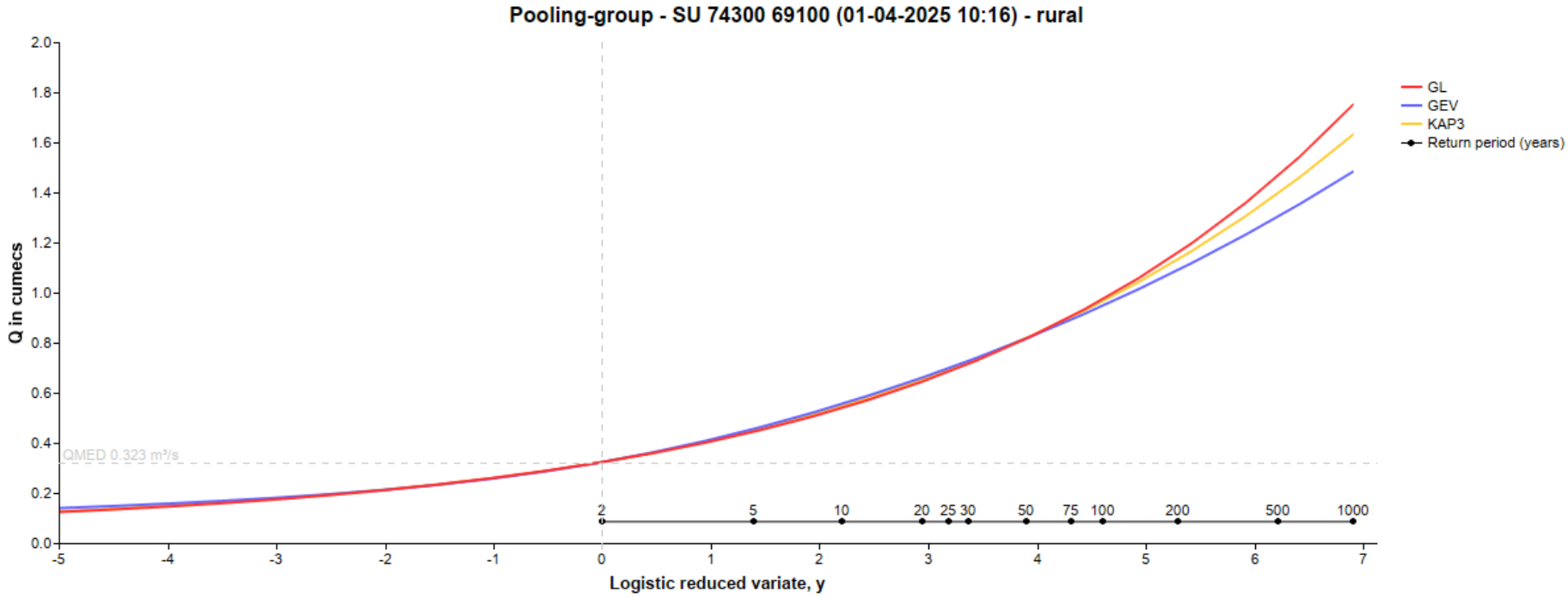
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.323	0.323	0.323
5	0.444	0.455	0.449
10	0.538	0.555	0.546
20	0.645	0.661	0.653
25	0.683	0.697	0.691
30	0.716	0.727	0.723
50	0.815	0.816	0.818
75	0.903	0.891	0.901
100	0.972	0.947	0.964
200	1.159	1.090	1.133
500	1.465	1.303	1.396
1000	1.752	1.484	1.632

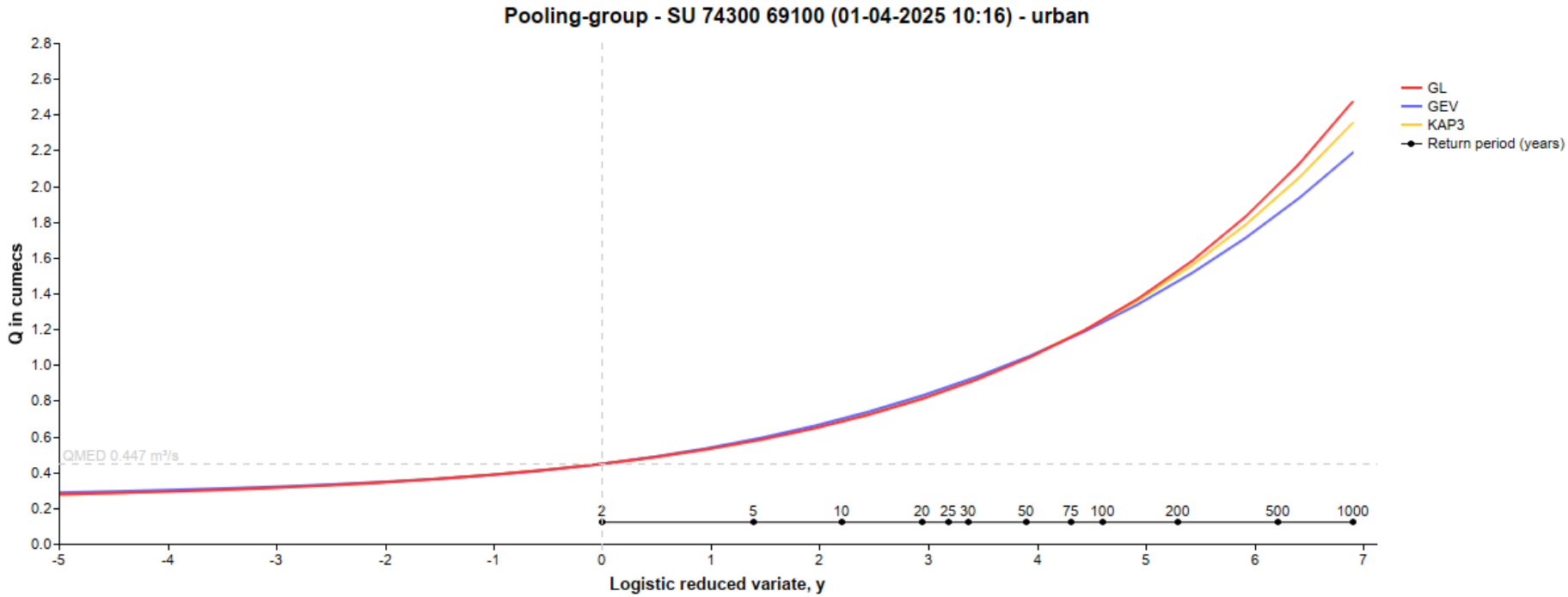
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.447	0.447	0.447
5	0.574	0.583	0.577
10	0.682	0.697	0.688
20	0.811	0.829	0.820
25	0.859	0.876	0.868
30	0.901	0.917	0.909
50	1.032	1.040	1.038
75	1.153	1.150	1.155
100	1.249	1.235	1.247
200	1.523	1.466	1.504
500	2.001	1.841	1.938
1000	2.477	2.189	2.357



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



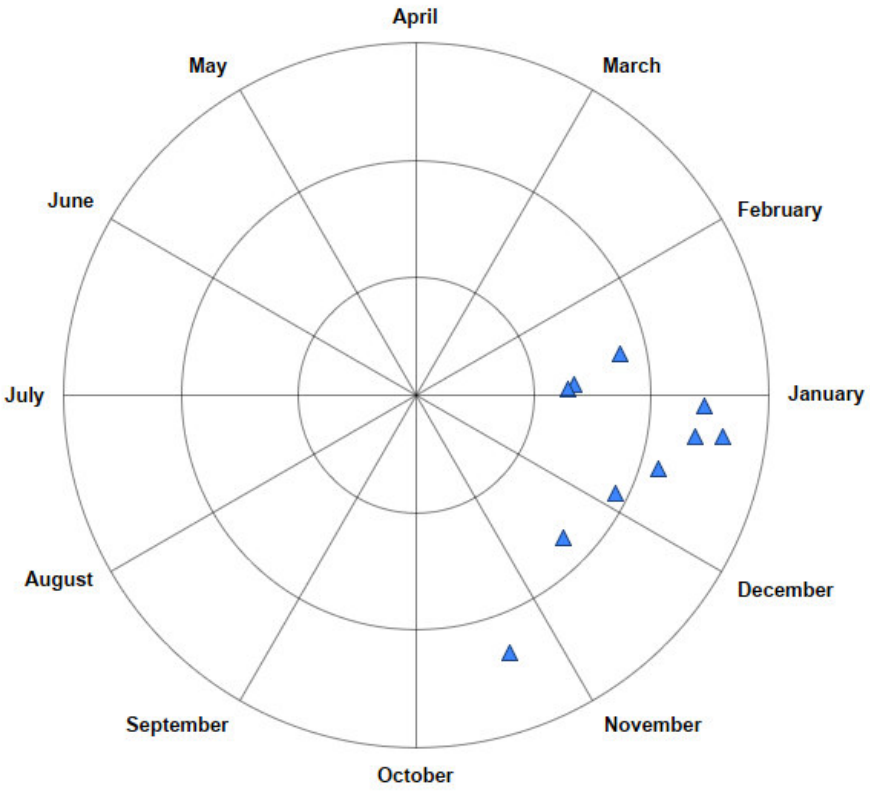
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

Flood seasonality: SU 74300 69100 (01-04-2025 10:16) - urban



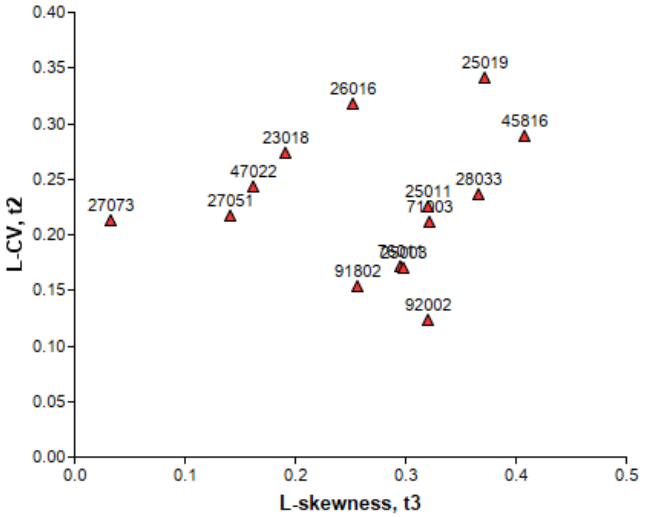
UK Design Flood Estimation

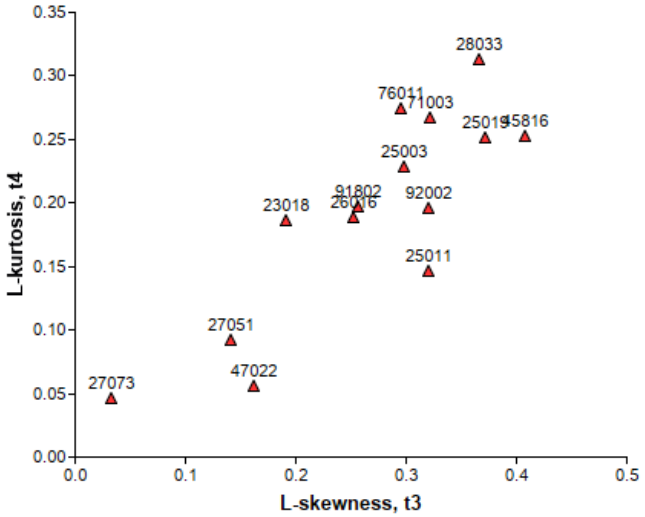
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

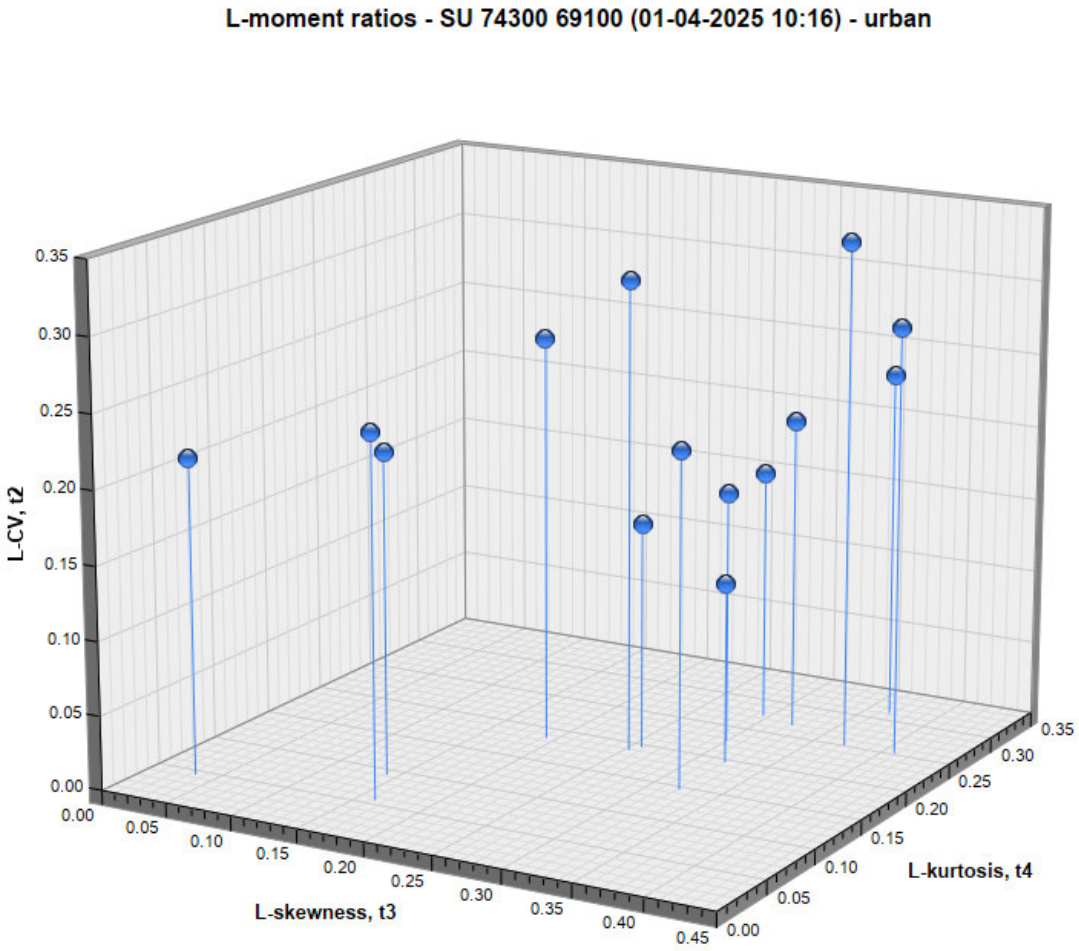
L-moment ratios - SU 74300 69100 (01-04-2025 10:16) - urban





UK Design Flood Estimation

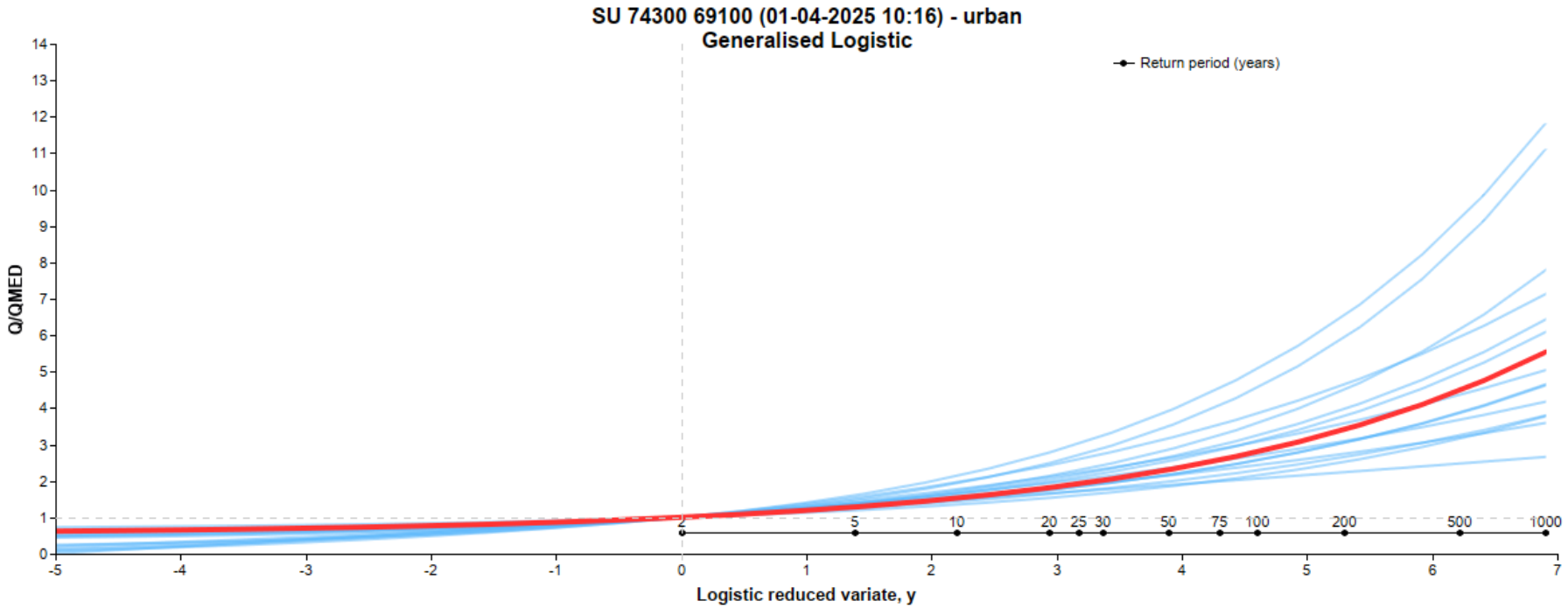
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

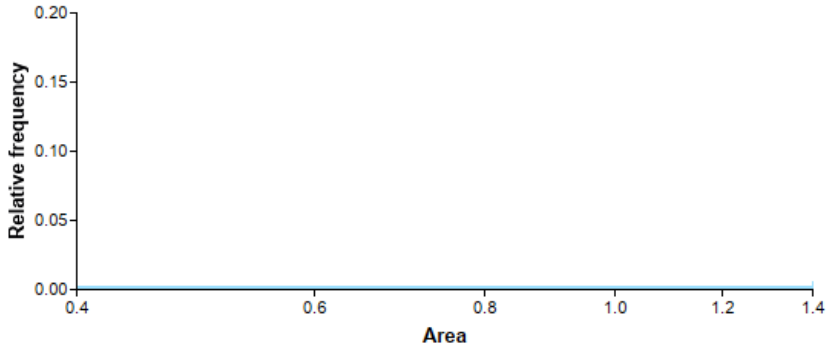
Pooling group growth curves

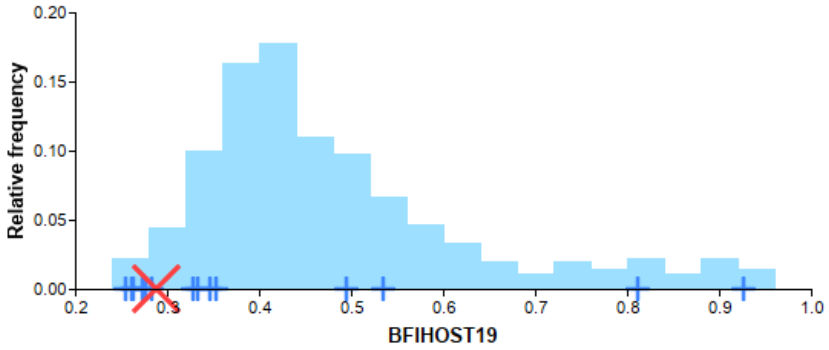


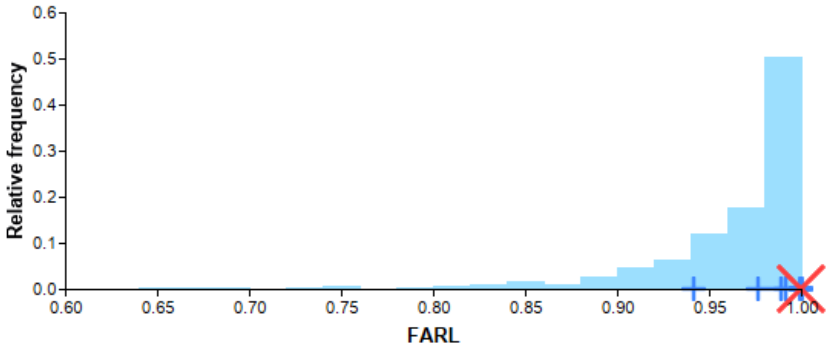
UK Design Flood Estimation

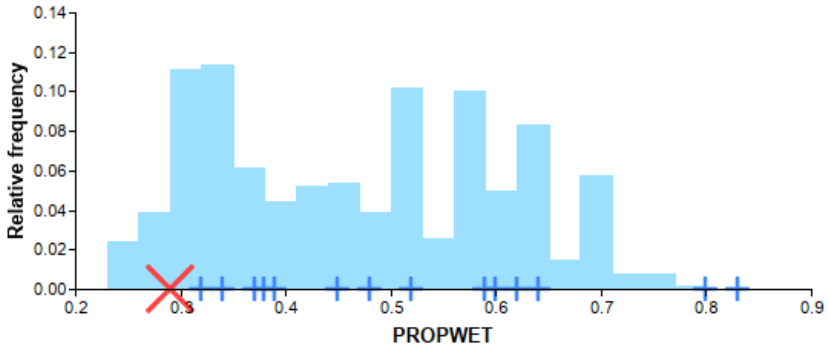
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



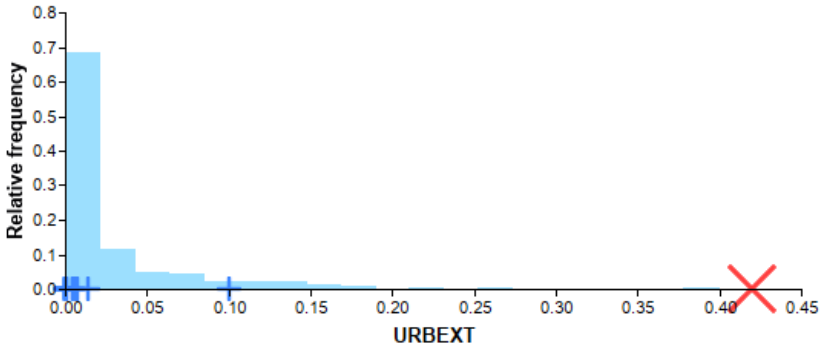


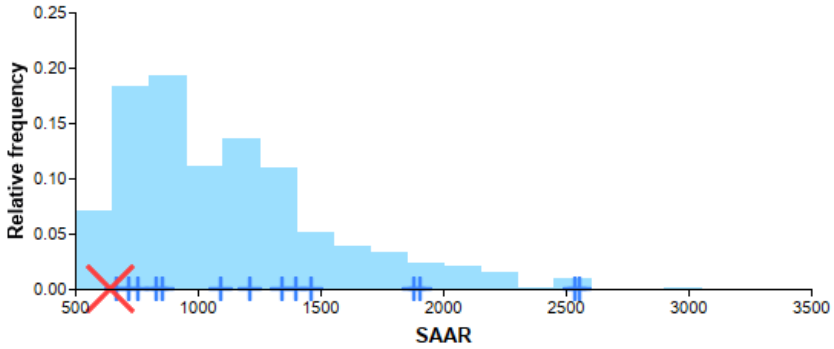


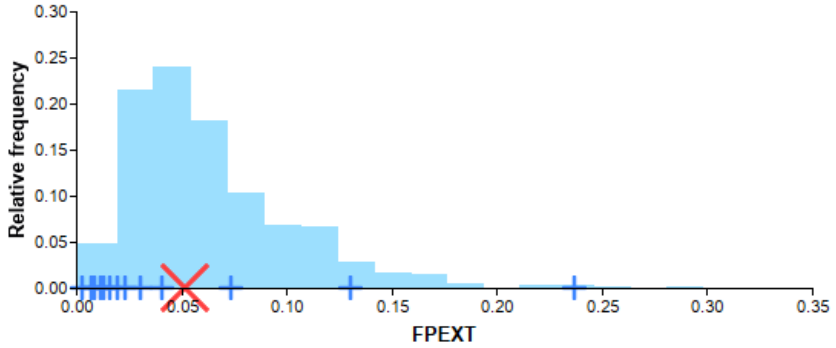


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	01-04-2025 11:18:00
Software:	WINFAP Version: 5.2.9046 (25885)
Peak Flow dataset:	Peak Flow Dataset 13.0.2
Supplementary data used:	No

Site details

Site number:	4105410641
Site name:	Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1
Site location:	SU 74300 69100
Easting:	474300
Northing:	169100
Catchment area:	0.92 km²
SAAR:	642 mm
BFIHOST19:	0.289
FPEXT:	0.052
FARL:	1.000
URBEXT2000:	0.4200

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.61 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.38229

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.420
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	1.320	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	3.081	30	3.352	0.288	**0.289**	0.408	**0.407**
27051 (Crimple @ Burn Bridge)	3.131	51	4.564	0.217	**0.217**	0.142	**0.141**
28033 (Dove @ Hollinsclough)	3.361	48	4.138	0.235	**0.235**	0.367	**0.367**
23018 (Ouse Burn @ Woolsington)	3.472	32	3.287	0.273	**0.290**	0.192	**0.175**
27073 (Brompton Beck @ Snainton Ings)	3.681	43	0.812	0.212	**0.213**	0.033	**0.032**
91802 (Allt Leachdach @ Intake)	3.842	34	6.350	0.153	**0.153**	0.257	**0.257**
25019 (Leven @ Easby)	3.956	45	5.090	0.341	**0.342**	0.373	**0.372**
26016 (Gypsey Race @ Kirby Grindalythe)	3.998	26	0.100	0.318	**0.318**	0.253	**0.253**
71003 (Croasdale Beck @ Croasdale Flume)	4.019	37	10.900	0.212	**0.212**	0.323	**0.323**
25011 (Langdon Beck @ Langdon)	4.025	37	15.647	0.225	**0.225**	0.321	**0.321**
92002 (Allt Coire nan Con @ Polloch)	4.053	22	13.573	0.122	**0.122**	0.320	**0.320**
47022 (Tory Brook @ Newnham Park)	4.063	28	6.134	0.243	**0.245**	0.163	**0.160**
25003 (Trout Beck @ Moor House)	4.087	50	15.182	0.170	**0.170**	0.299	**0.299**
Total		**529**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
76011 (Coal Burn @ Coalburn)	Yes	Yes	46	0	0.00			1.004	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.079	
27051 (Crimple @ Burn Bridge)	Yes	Yes	51	3	5.88	1.34	None	0.575	
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			0.886	
23018 (Ouse Burn @ Woolsington)	Yes	Yes	32	4	12.50	0.70	None	0.899	
27073 (Brompton Beck @ Snainton Ings)	Yes	Yes	43	2	4.65	0.92	None	1.880	
91802 (Allt Leachdach @ Intake)	Yes	Yes	34	0	0.00	-0.42	None	0.505	
25019 (Leven @ Easby)	Yes	Yes	45	3	6.67			1.419	
26016 (Gypsey Race @ Kirby Grindalythe)	Yes	Yes	26	4	15.38			0.820	
71003 (Croasdale Beck @ Croasdale Flume)	Yes	Yes	37	1	2.70			0.392	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			1.431	
92002 (Allt Coire nan Con @ Polloch)	Yes	Yes	22	0	0.00			1.512	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			1.211	
25003 (Trout Beck @ Moor House)	Yes	Yes	50	1	2.00			0.386	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
76011 (Coal Burn @ Coalburn)	1.630	1096	0.074	1.000	0.000	0.274
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
27051 (Crimple @ Burn Bridge)	8.172	855	0.013	1.000	0.006	0.329
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
23018 (Ouse Burn @ Woolsington)	10.137	670	0.131	0.977	0.100	0.333
27073 (Brompton Beck @ Snainton Ings)	8.060	721	0.237	1.000	0.008	0.811
91802 (Allt Leachdach @ Intake)	6.522	2555	0.003	0.992	0.000	0.277
25019 (Leven @ Easby)	15.088	830	0.019	1.000	0.004	0.495
26016 (Gypsey Race @ Kirby Grindalythe)	15.850	757	0.030	1.000	0.000	0.927
71003 (Croasdale Beck @ Croasdale Flume)	10.710	1882	0.016	1.000	0.000	0.283
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
92002 (Allt Coire nan Con @ Polloch)	8.148	2538	0.009	0.989	0.000	0.261
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
25003 (Trout Beck @ Moor House)	11.395	1905	0.041	1.000	0.000	0.255

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.227	Urban L-CV:	0.177
Rural L-Skewness:	0.266	Urban L-Skewness:	0.344

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.223	-0.266		0.160
GEV	0.882	0.314	-0.144		-1.305
KAP3	0.939	0.263	-0.211	-0.400	-0.307

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.160	-0.344		0.536
GEV	0.919	0.211	-0.254		0.090
KAP3	0.958	0.182	-0.305	-0.400	0.360

Goodness of fit

GL:	1.0197 *
GEV:	-0.3145 *
P3:	-2.3808
GP:	-3.7098
KAP3:	0.5810 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 1.8019

The pooling group is possibly heterogeneous and a review of the pooling group is optional.

Standardised growth curves

Rural

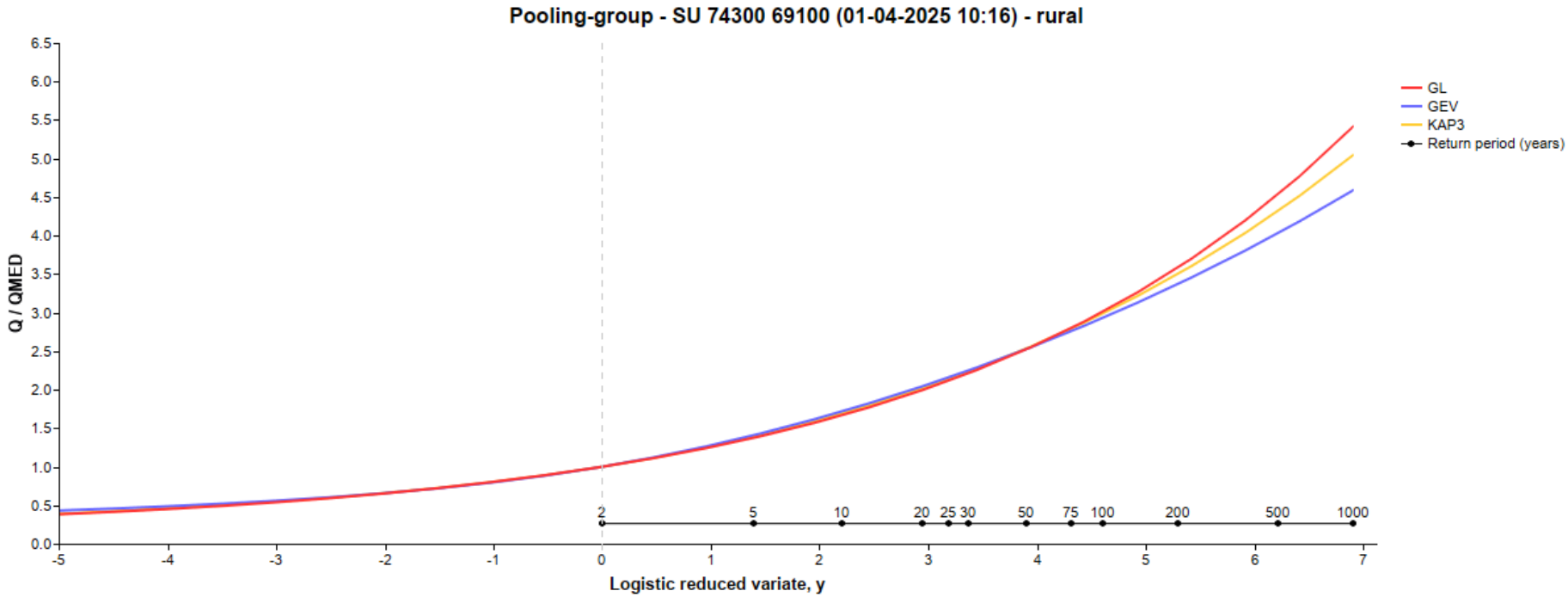
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.374	1.407	1.388
10	1.665	1.716	1.688
20	1.996	2.045	2.021
25	2.113	2.156	2.137
30	2.214	2.250	2.235
50	2.521	2.524	2.531
75	2.794	2.756	2.787
100	3.006	2.928	2.982
200	3.586	3.372	3.503
500	4.533	4.031	4.318
1000	5.418	4.590	5.047

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.284	1.304	1.292
10	1.525	1.560	1.540
20	1.815	1.855	1.834
25	1.922	1.961	1.942
30	2.016	2.052	2.035
50	2.309	2.328	2.323
75	2.579	2.573	2.584
100	2.795	2.763	2.790
200	3.408	3.281	3.365
500	4.478	4.120	4.337
1000	5.542	4.898	5.275

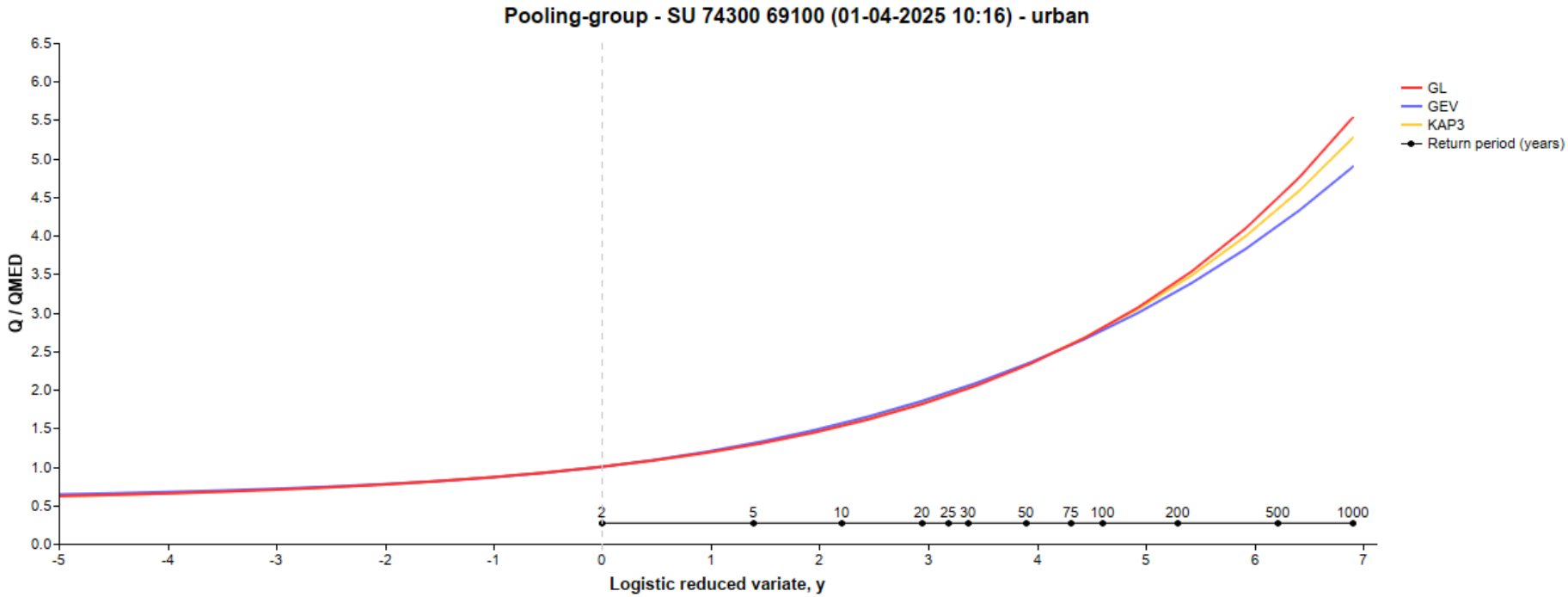
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.420
Donor adjusted FSE:	1.363
No. of donors:	6

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
39052 (The Cut @ Binfield)	15.12	Yes	7.543	**6.110**	9.547	7.733
39007 (Blackwater @ Swallowfield)	16.12	Yes	22.300	**17.972**	17.807	14.351
39022 (Loddon @ Sheepbridge)	17.14	Yes	16.350	**14.203**	13.034	11.322
39001 (Thames @ Kingston)	21.13	Yes	316.110	**282.569**	324.496	290.065
39027 (Pang @ Pangbourne)	21.21	Yes	2.140	**2.081**	6.817	6.817
39025 (Enborne @ Brimpton)	26.39	Yes	16.700	**16.271**	18.310	18.310

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
39052 (The Cut @ Binfield)	Yes	No	66	2	3.03	1.22	None	
39007 (Blackwater @ Swallowfield)	Yes	Yes	70	0	0.00	1.42	None	
39022 (Loddon @ Sheepbridge)	Yes	Yes	58	2	3.45	-1.10	None	
39001 (Thames @ Kingston)	Yes	Yes	140	4	2.86	1.65	10	
39027 (Pang @ Pangbourne)	Yes	No	55	1	1.82	-1.76	10	
39025 (Enborne @ Brimpton)	Yes	Yes	56	0	0.00	-1.11	None	

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1 @ SU 74300 69100)	0.920	473623	169642	642	0.052	1.000	0.420	0.289
39052 (The Cut @ Binfield)	49.998	488740	169768	676	0.127	0.939	0.237	0.366
39007 (Blackwater @ Swallowfield)	359.810	479802	154750	708	0.132	0.886	0.132	0.674
39022 (Loddon @ Sheepbridge)	176.773	464845	154923	735	0.102	0.947	0.087	0.664
39001 (Thames @ Kingston)	9930.798	462899	187850	706	0.148	0.942	0.066	0.679
39027 (Pang @ Pangbourne)	175.683	453633	176722	694	0.063	0.996	0.012	0.782
39025 (Enborne @ Brimpton)	142.010	448695	160991	789	0.075	0.978	0.020	0.563

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
39023 (Wye @ Bourne End Hedsor)	27.81	0.113	Yes	2.730	**1.992**	6.665	4.864	483929	195468	134.183	755	0.839	0.984	59	Yes	Yes
39033 (Winterbourne Stream @ Bagnor)	29.35	0.001	Yes	0.399	**0.398**	2.053	2.053	445079	176491	45.312	717	0.812	1.000	61	Yes	Yes
42009 (Candover Stream @ Borough Bridge)	31.05	0.011	Yes	1.065	**1.011**	1.806	1.806	460964	141288	72.062	819	0.924	0.930	52	Yes	Yes
39011 (Wey @ Tilford)	32.32	0.053	Yes	25.800	**22.877**	22.987	20.383	477280	137531	391.325	855	0.773	0.957	69	Yes	No

QMED

Rural: 0.285 m³/s

Urban: 0.394 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

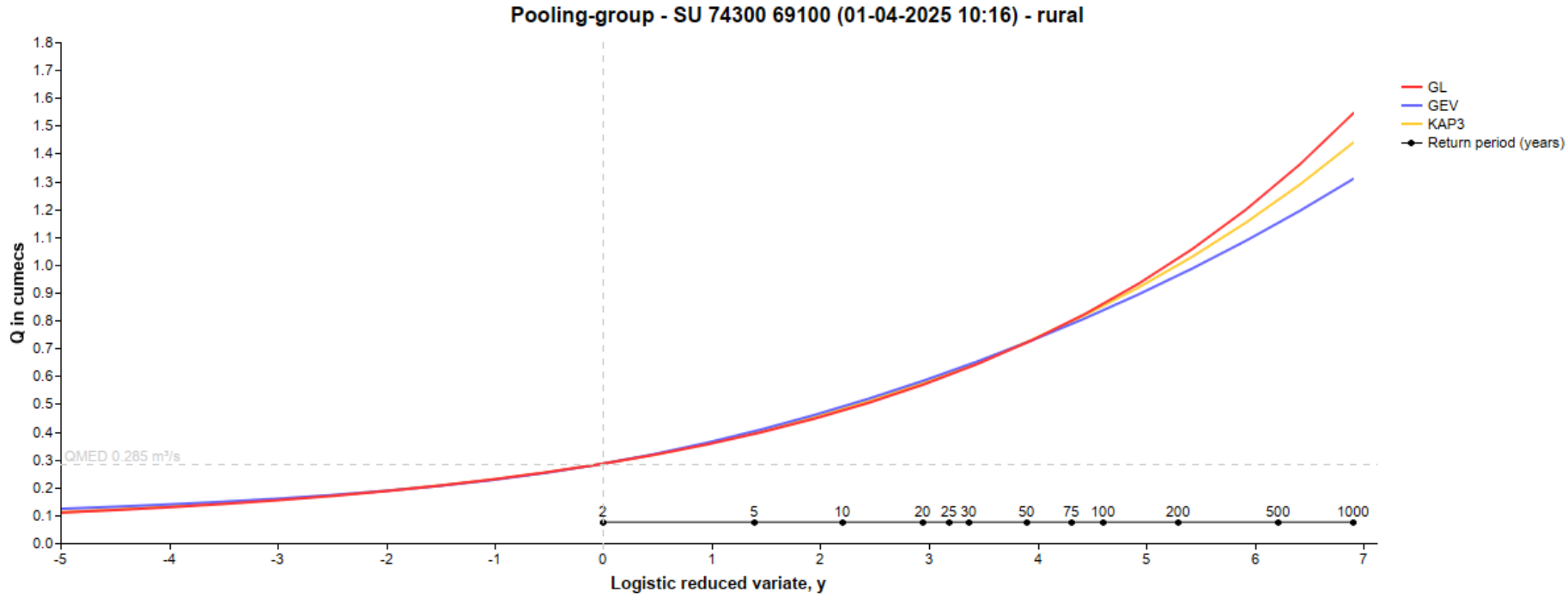
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.285	0.285	0.285
5	0.392	0.401	0.396
10	0.475	0.489	0.482
20	0.569	0.583	0.576
25	0.603	0.615	0.610
30	0.632	0.642	0.638
50	0.719	0.720	0.722
75	0.797	0.786	0.795
100	0.857	0.835	0.851
200	1.023	0.962	0.999
500	1.293	1.150	1.232
1000	1.546	1.309	1.440

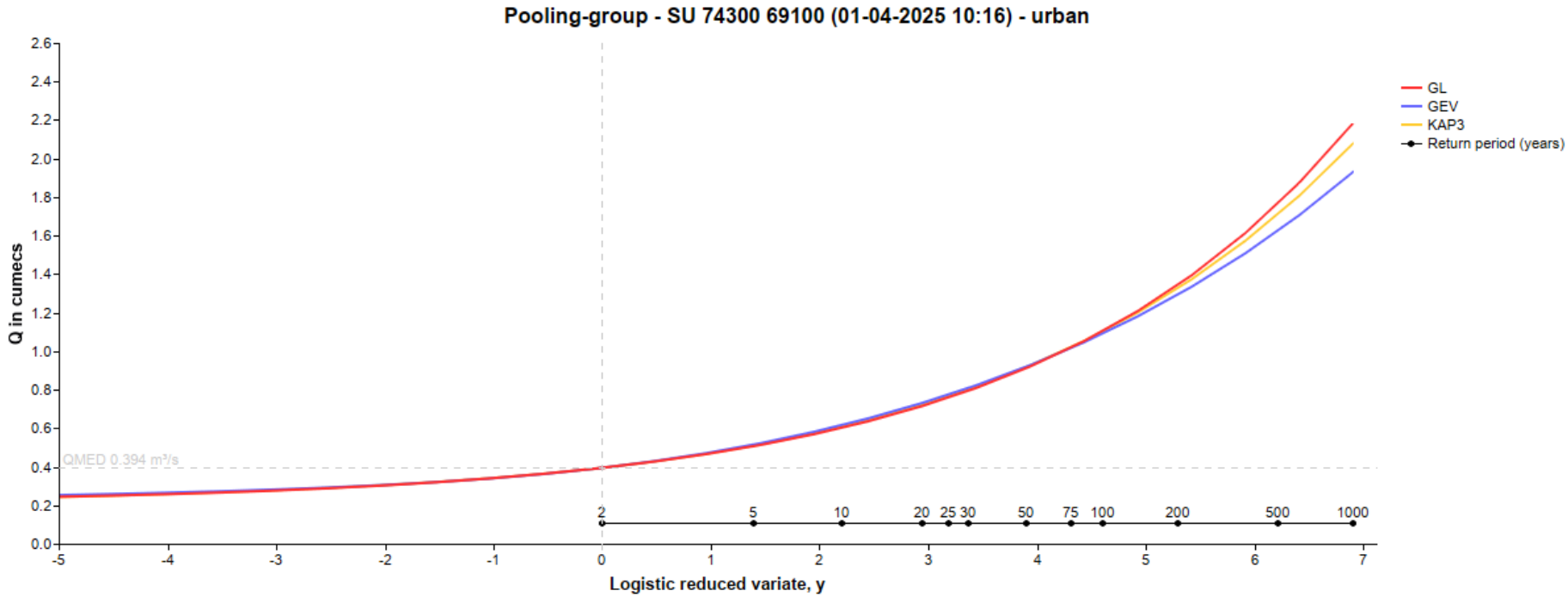
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.394	0.394	0.394
5	0.506	0.514	0.509
10	0.601	0.615	0.607
20	0.716	0.732	0.723
25	0.758	0.773	0.766
30	0.795	0.809	0.802
50	0.910	0.918	0.916
75	1.017	1.015	1.019
100	1.102	1.090	1.100
200	1.344	1.294	1.327
500	1.766	1.625	1.710
1000	2.185	1.932	2.080



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



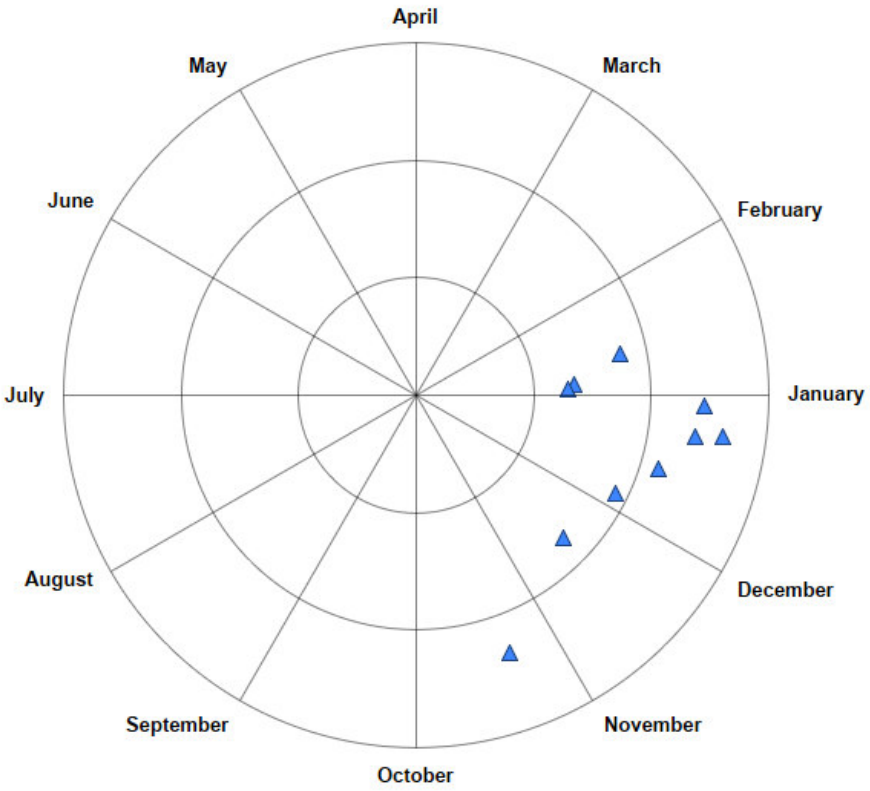
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

Flood seasonality: SU 74300 69100 (01-04-2025 10:16) - urban



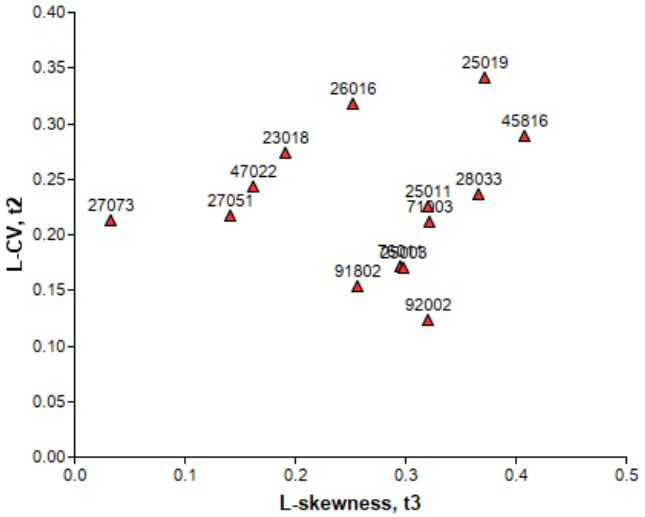
UK Design Flood Estimation

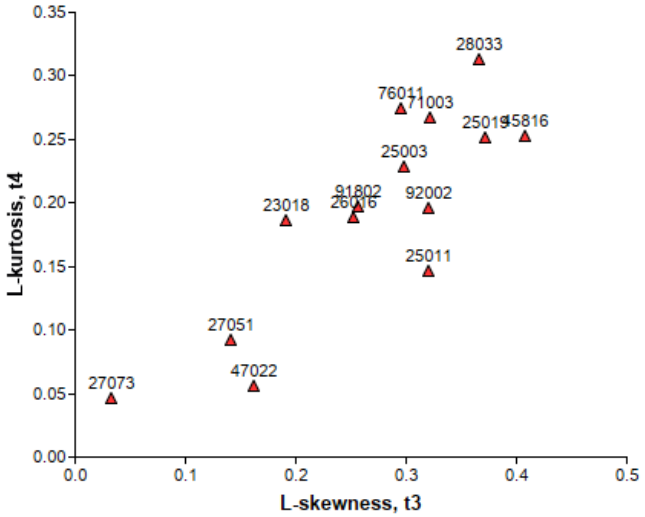
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

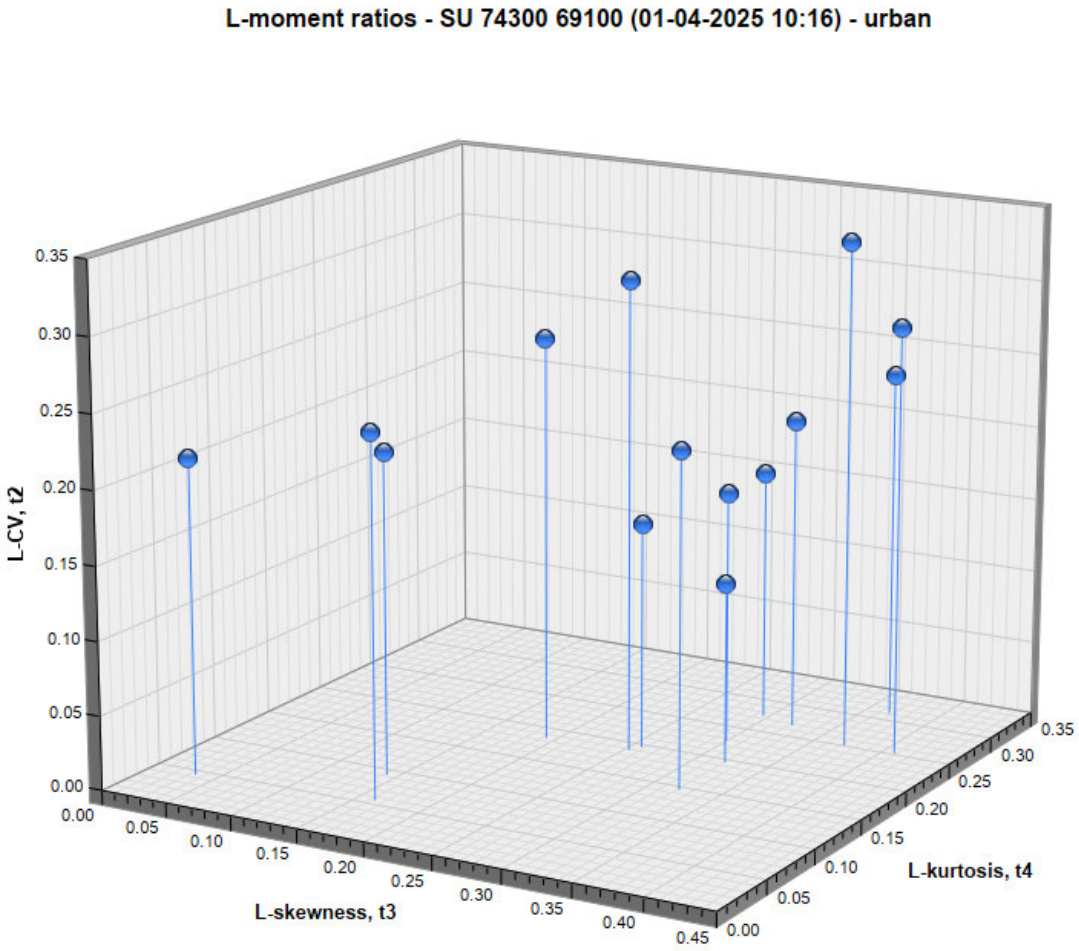
L-moment ratios - SU 74300 69100 (01-04-2025 10:16) - urban





UK Design Flood Estimation

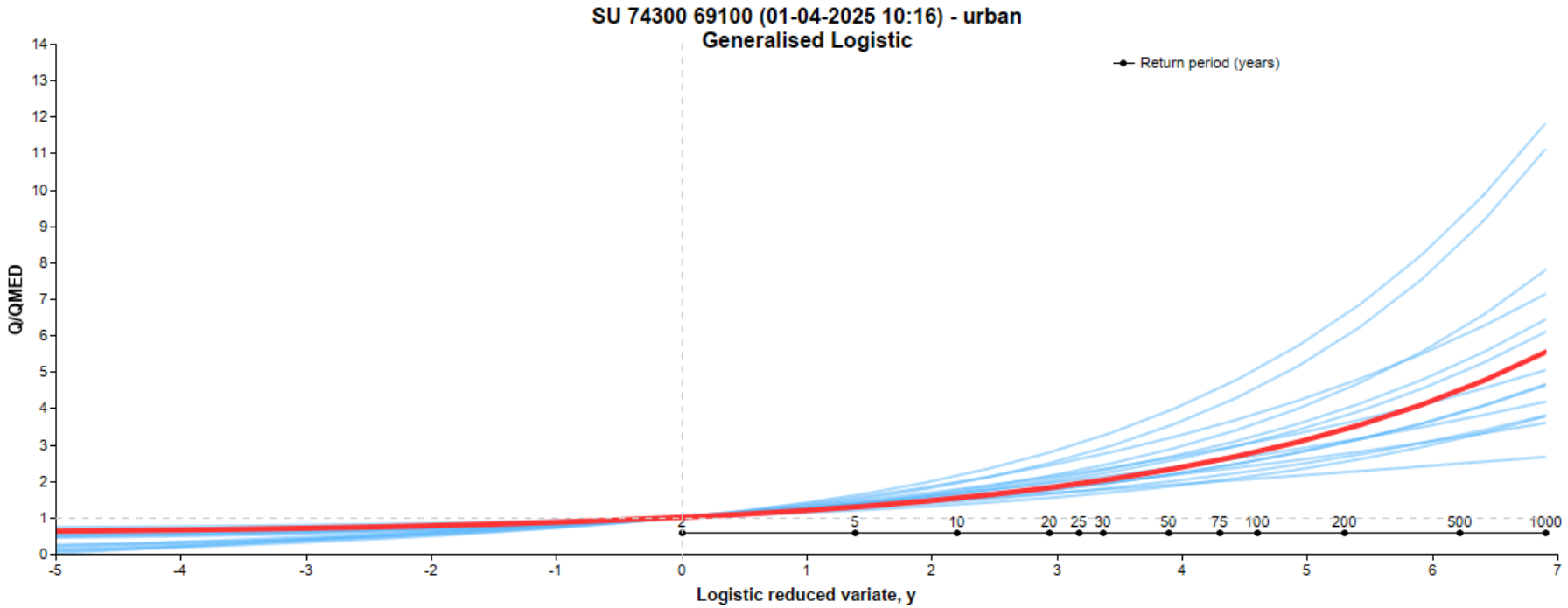
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

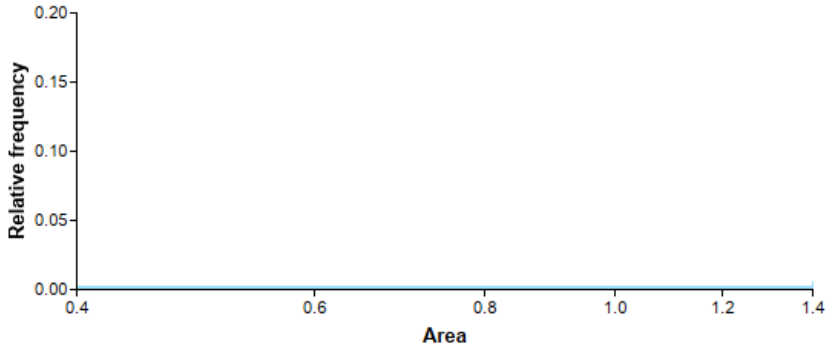
Pooling group growth curves

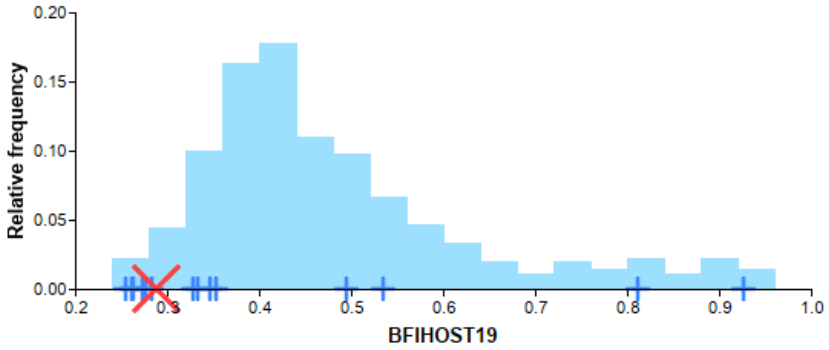


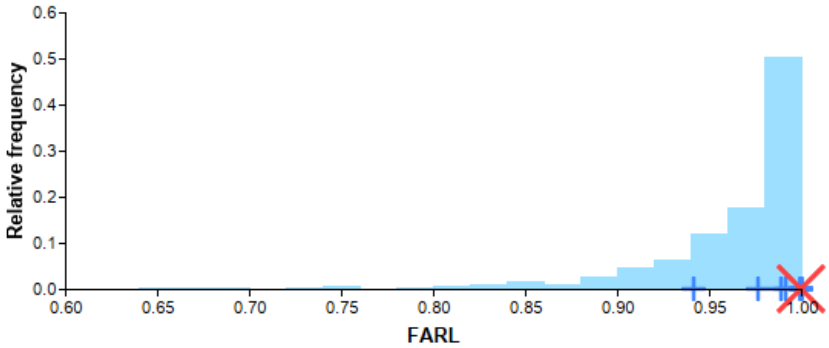
UK Design Flood Estimation

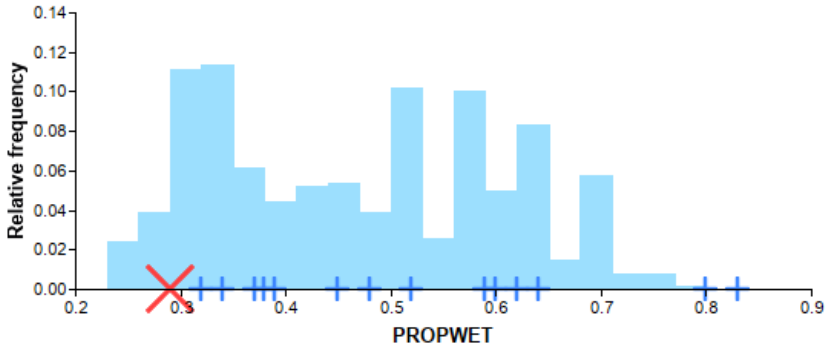
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



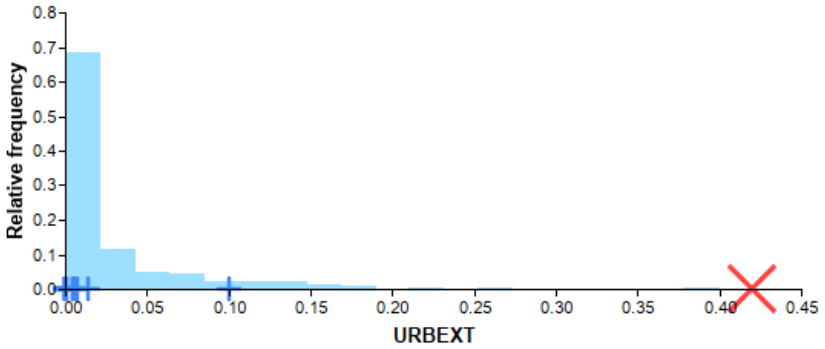


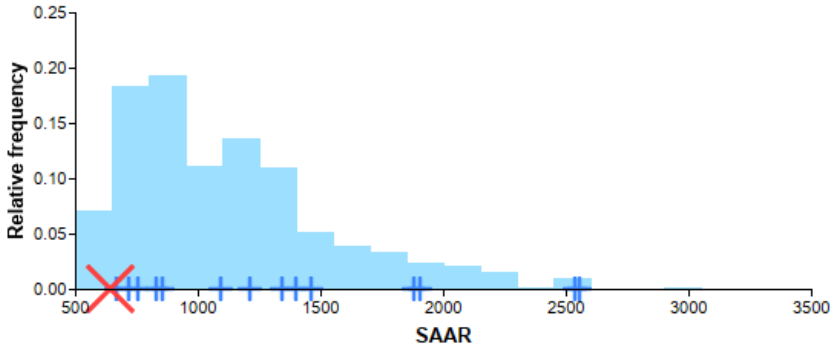


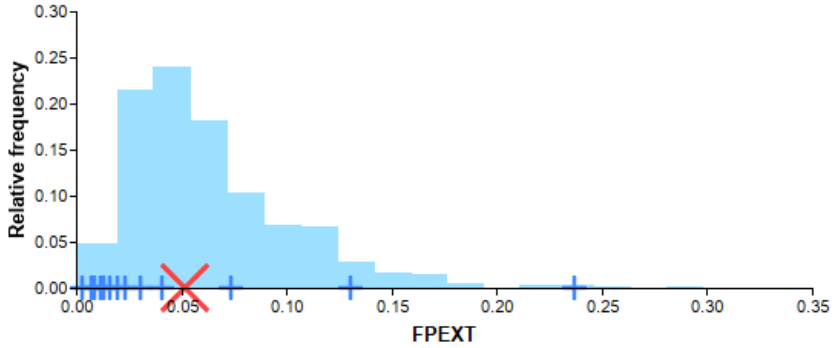


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	01-04-2025 11:19:51
Software:	WINFAP Version: 5.2.9046 (25885)
Peak Flow dataset:	Peak Flow Dataset 13.0.2
Supplementary data used:	No

Site details

Site number:	4105410641
Site name:	Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1
Site location:	SU 74300 69100
Easting:	474300
Northing:	169100
Catchment area:	0.92 km²
SAAR:	642 mm
BFIHOST19:	0.289
FPEXT:	0.052
FARL:	1.000
URBEXT2000:	0.4200

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.61 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.38229

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.420
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Catchment Descriptors

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	1.320	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	3.081	30	3.352	0.288	**0.289**	0.408	**0.407**
27051 (Crimple @ Burn Bridge)	3.131	51	4.564	0.217	**0.217**	0.142	**0.141**
28033 (Dove @ Hollinsclough)	3.361	48	4.138	0.235	**0.235**	0.367	**0.367**
23018 (Ouse Burn @ Woolsington)	3.472	32	3.287	0.273	**0.290**	0.192	**0.175**
27073 (Brompton Beck @ Snainton Ings)	3.681	43	0.812	0.212	**0.213**	0.033	**0.032**
91802 (Allt Leachdach @ Intake)	3.842	34	6.350	0.153	**0.153**	0.257	**0.257**
25019 (Leven @ Easby)	3.956	45	5.090	0.341	**0.342**	0.373	**0.372**
26016 (Gypsey Race @ Kirby Grindalythe)	3.998	26	0.100	0.318	**0.318**	0.253	**0.253**
71003 (Croasdale Beck @ Croasdale Flume)	4.019	37	10.900	0.212	**0.212**	0.323	**0.323**
25011 (Langdon Beck @ Langdon)	4.025	37	15.647	0.225	**0.225**	0.321	**0.321**
92002 (Allt Coire nan Con @ Polloch)	4.053	22	13.573	0.122	**0.122**	0.320	**0.320**
47022 (Tory Brook @ Newnham Park)	4.063	28	6.134	0.243	**0.245**	0.163	**0.160**
25003 (Trout Beck @ Moor House)	4.087	50	15.182	0.170	**0.170**	0.299	**0.299**
Total		**529**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
76011 (Coal Burn @ Coalburn)	Yes	Yes	46	0	0.00			1.004	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.079	
27051 (Crimple @ Burn Bridge)	Yes	Yes	51	3	5.88	1.34	None	0.575	
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			0.886	
23018 (Ouse Burn @ Woolsington)	Yes	Yes	32	4	12.50	0.70	None	0.899	
27073 (Brompton Beck @ Snainton Ings)	Yes	Yes	43	2	4.65	0.92	None	1.880	
91802 (Allt Leachdach @ Intake)	Yes	Yes	34	0	0.00	-0.42	None	0.505	
25019 (Leven @ Easby)	Yes	Yes	45	3	6.67			1.419	
26016 (Gypsey Race @ Kirby Grindalythe)	Yes	Yes	26	4	15.38			0.820	
71003 (Croasdale Beck @ Croasdale Flume)	Yes	Yes	37	1	2.70			0.392	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			1.431	
92002 (Allt Coire nan Con @ Polloch)	Yes	Yes	22	0	0.00			1.512	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			1.211	
25003 (Trout Beck @ Moor House)	Yes	Yes	50	1	2.00			0.386	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
76011 (Coal Burn @ Coalburn)	1.630	1096	0.074	1.000	0.000	0.274
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
27051 (Crimple @ Burn Bridge)	8.172	855	0.013	1.000	0.006	0.329
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
23018 (Ouse Burn @ Woolsington)	10.137	670	0.131	0.977	0.100	0.333
27073 (Brompton Beck @ Snainton Ings)	8.060	721	0.237	1.000	0.008	0.811
91802 (Allt Leachdach @ Intake)	6.522	2555	0.003	0.992	0.000	0.277
25019 (Leven @ Easby)	15.088	830	0.019	1.000	0.004	0.495
26016 (Gypsey Race @ Kirby Grindalythe)	15.850	757	0.030	1.000	0.000	0.927
71003 (Croasdale Beck @ Croasdale Flume)	10.710	1882	0.016	1.000	0.000	0.283
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
92002 (Allt Coire nan Con @ Polloch)	8.148	2538	0.009	0.989	0.000	0.261
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
25003 (Trout Beck @ Moor House)	11.395	1905	0.041	1.000	0.000	0.255

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.227	Urban L-CV:	0.177
Rural L-Skewness:	0.266	Urban L-Skewness:	0.344

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.223	-0.266		0.160
GEV	0.882	0.314	-0.144		-1.305
KAP3	0.939	0.263	-0.211	-0.400	-0.307

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.160	-0.344		0.536
GEV	0.919	0.211	-0.254		0.090
KAP3	0.958	0.182	-0.305	-0.400	0.360

Goodness of fit

GL:	1.0639 *
GEV:	-0.3463 *
P3:	-2.5304
GP:	-3.9350
KAP3:	0.6002 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 1.6994

The pooling group is possibly heterogeneous and a review of the pooling group is optional.

Standardised growth curves

Rural

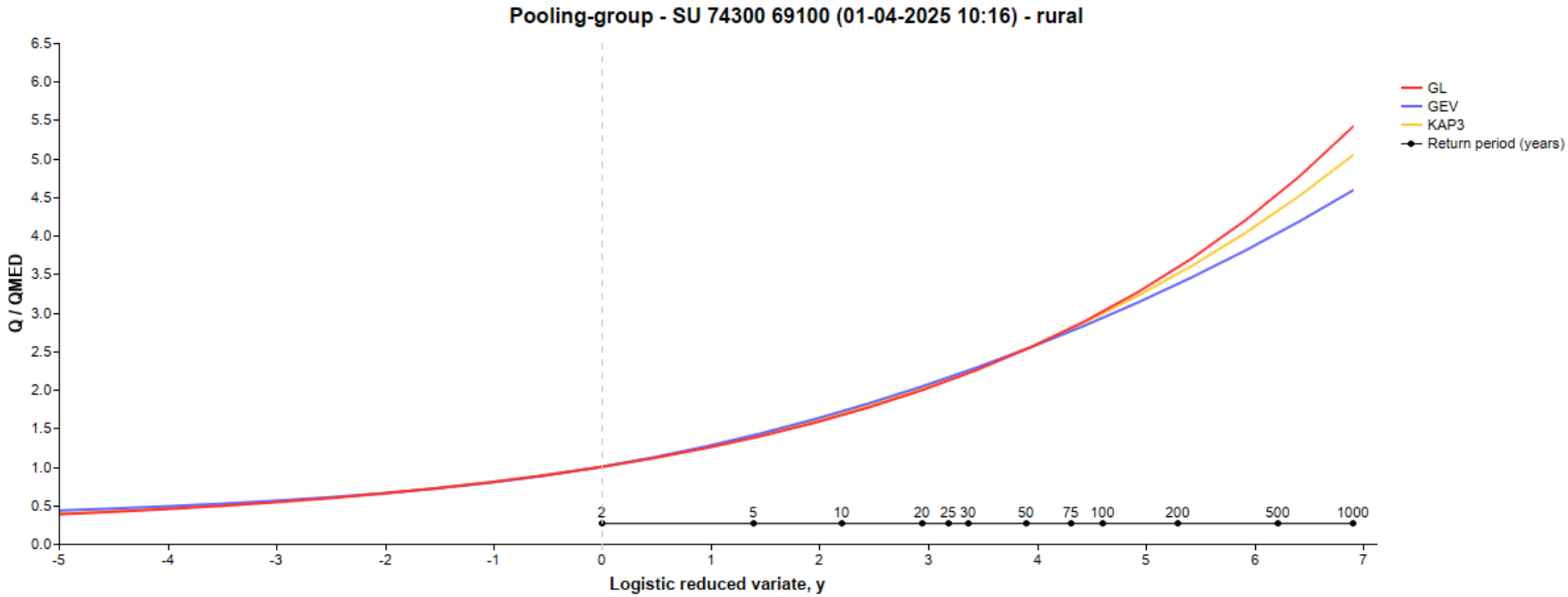
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.374	1.407	1.388
10	1.665	1.716	1.688
20	1.996	2.045	2.021
25	2.113	2.156	2.137
30	2.214	2.250	2.235
50	2.521	2.524	2.531
75	2.794	2.756	2.787
100	3.006	2.928	2.982
200	3.586	3.372	3.503
500	4.533	4.031	4.318
1000	5.418	4.590	5.047

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.284	1.304	1.292
10	1.525	1.560	1.540
20	1.815	1.855	1.834
25	1.922	1.961	1.942
30	2.016	2.052	2.035
50	2.309	2.328	2.323
75	2.579	2.573	2.584
100	2.795	2.763	2.790
200	3.408	3.281	3.365
500	4.478	4.120	4.337
1000	5.542	4.898	5.275

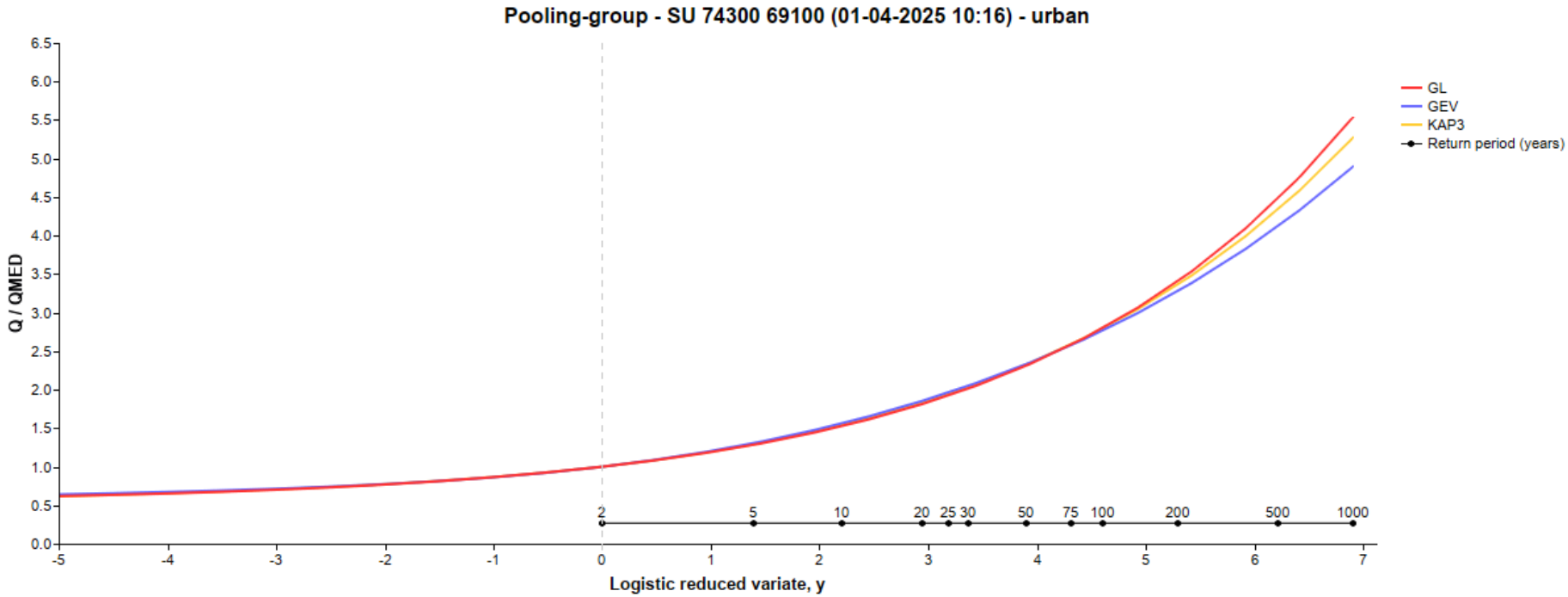
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

QMED	
Rural:	0.323 m³/s
Urban:	0.447 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

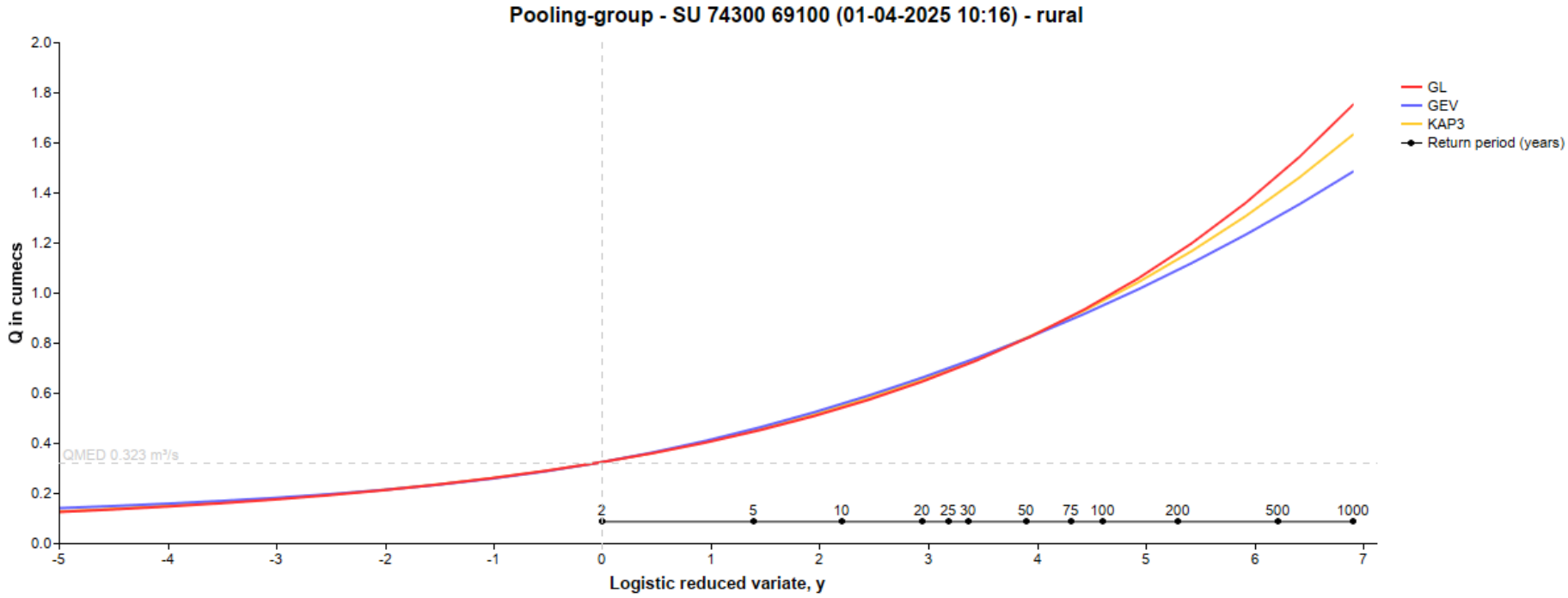
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.323	0.323	0.323
5	0.444	0.455	0.449
10	0.538	0.555	0.546
20	0.645	0.661	0.653
25	0.683	0.697	0.691
30	0.716	0.727	0.723
50	0.815	0.816	0.818
75	0.903	0.891	0.901
100	0.972	0.947	0.964
200	1.159	1.090	1.133
500	1.465	1.303	1.396
1000	1.752	1.484	1.632

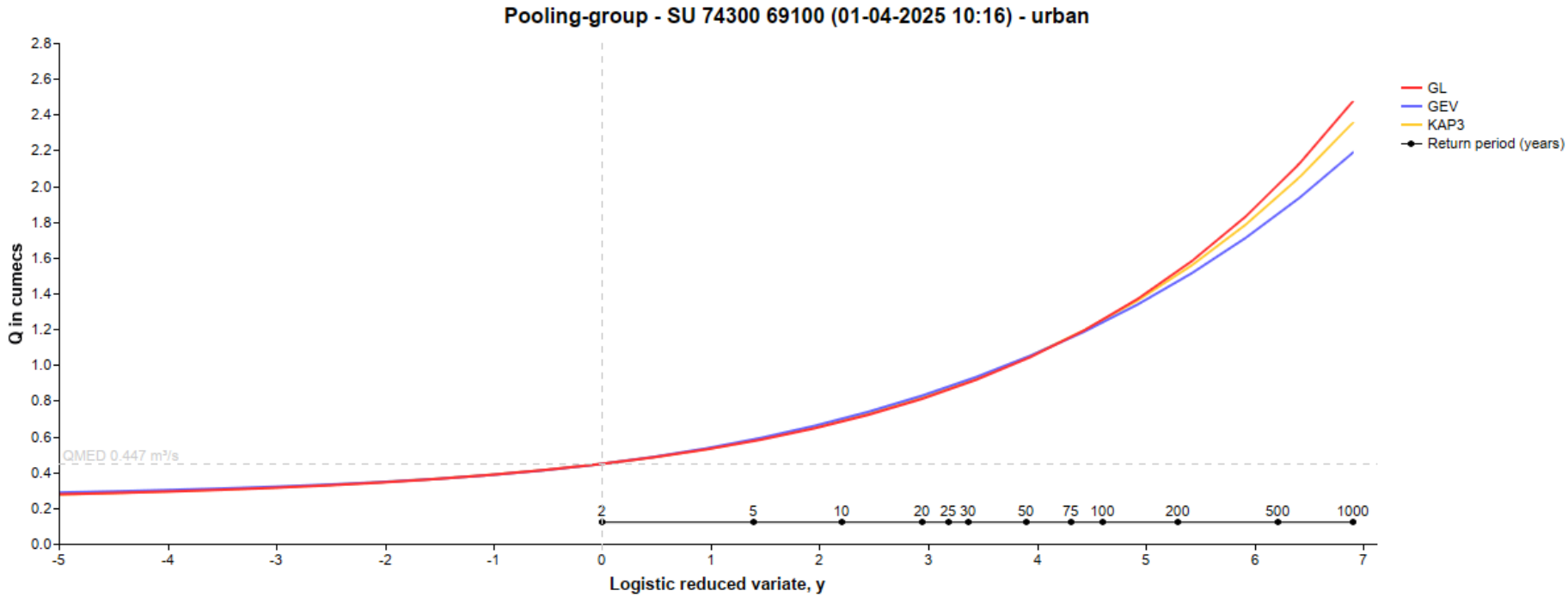
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.447	0.447	0.447
5	0.574	0.583	0.577
10	0.682	0.697	0.688
20	0.811	0.829	0.820
25	0.859	0.876	0.868
30	0.901	0.917	0.909
50	1.032	1.040	1.038
75	1.153	1.150	1.155
100	1.249	1.235	1.247
200	1.523	1.466	1.504
500	2.001	1.841	1.938
1000	2.477	2.189	2.357



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



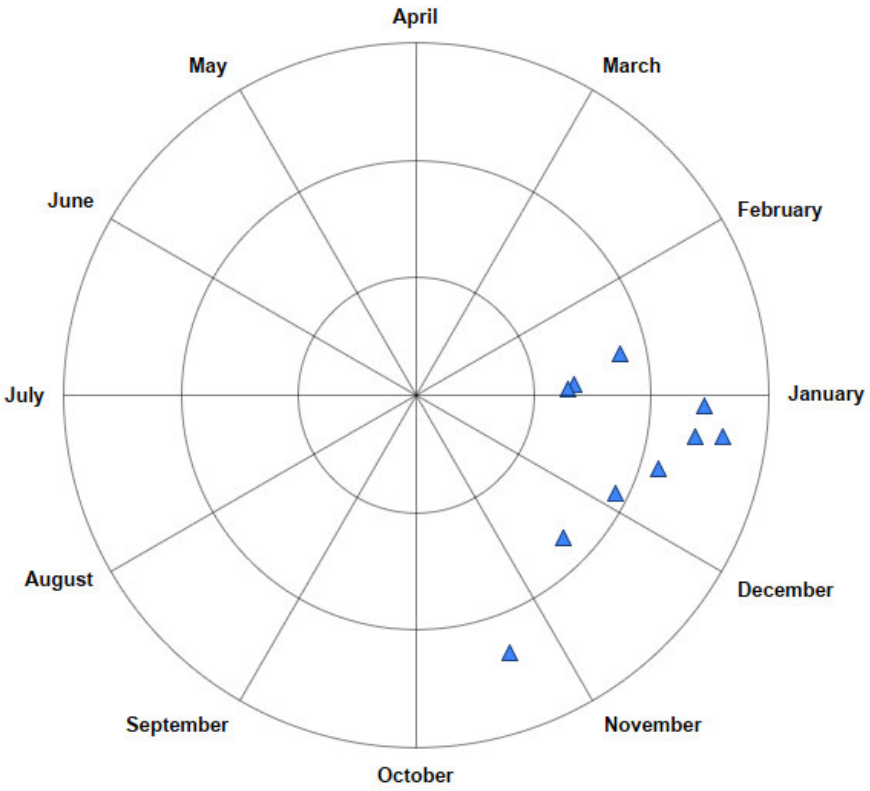
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

Flood seasonality: SU 74300 69100 (01-04-2025 10:16) - urban



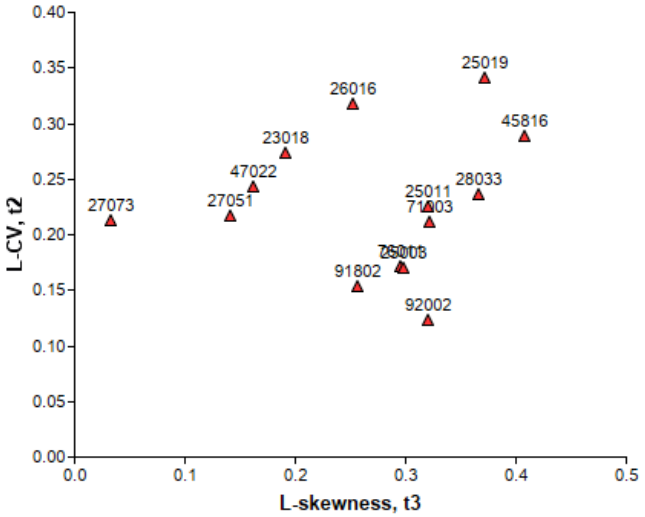
UK Design Flood Estimation

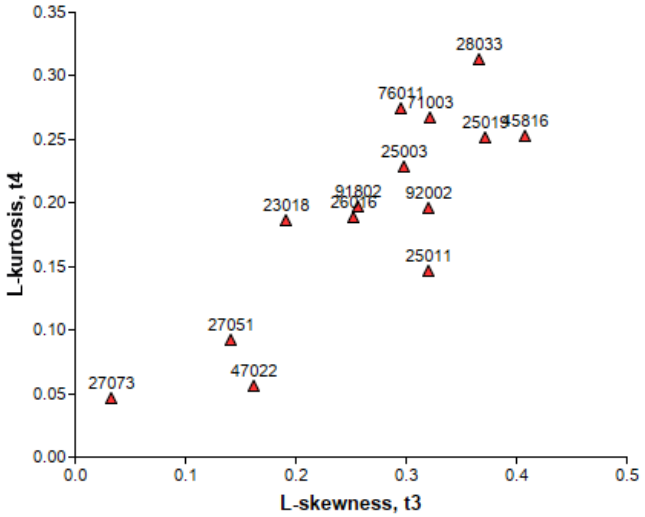
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

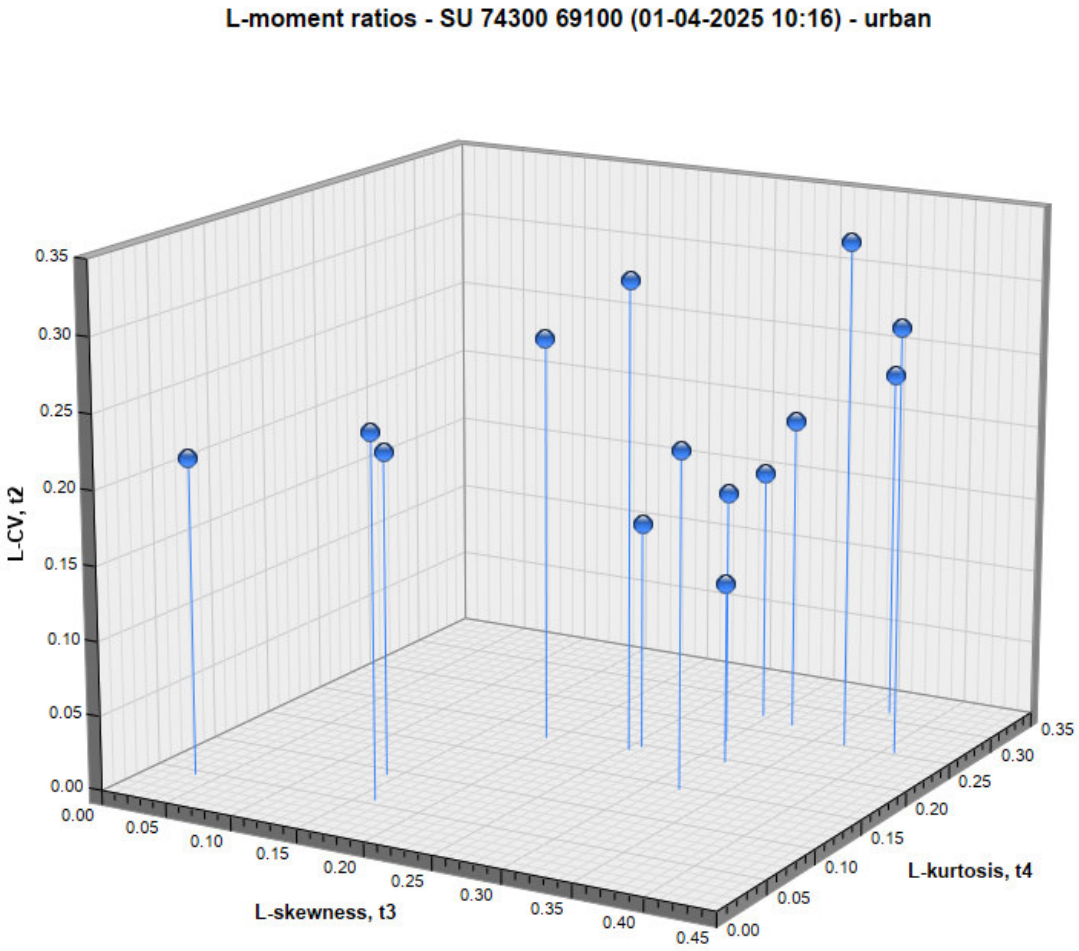
L-moment ratios - SU 74300 69100 (01-04-2025 10:16) - urban





UK Design Flood Estimation

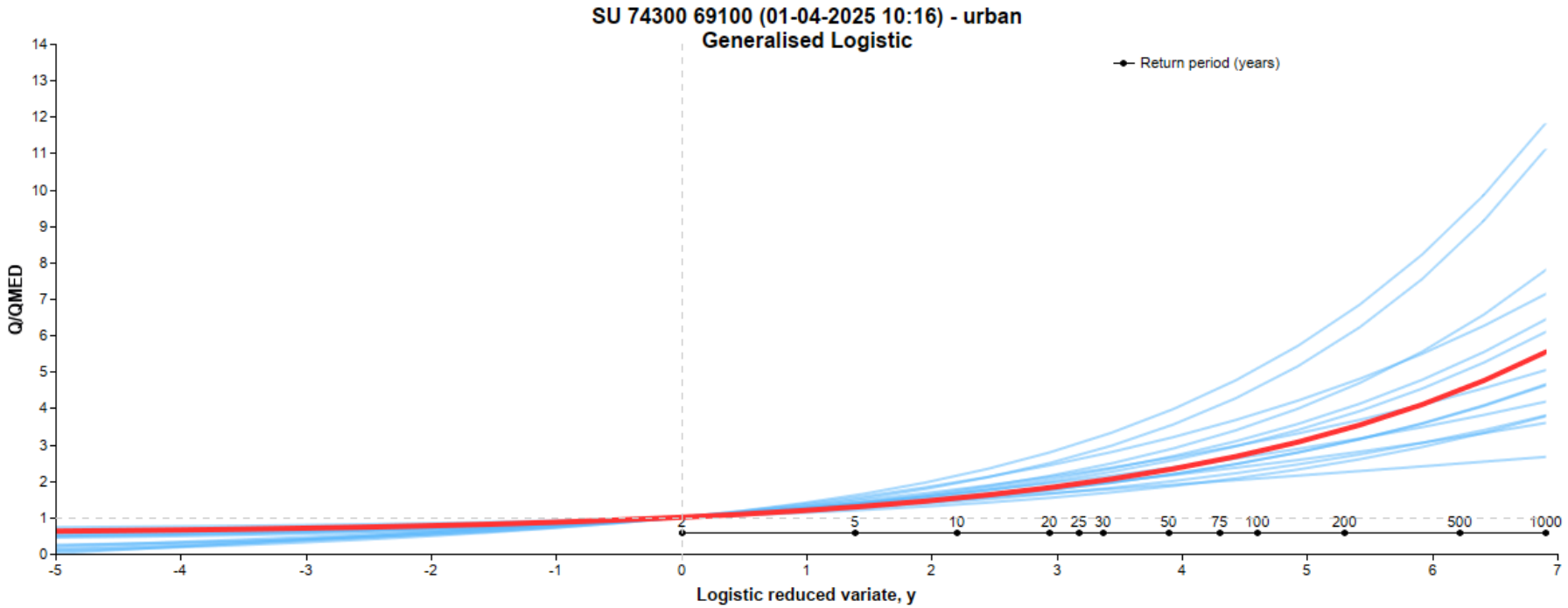
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

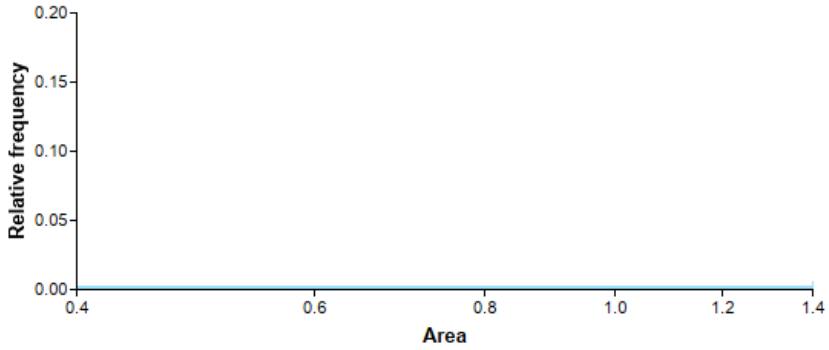
Pooling group growth curves

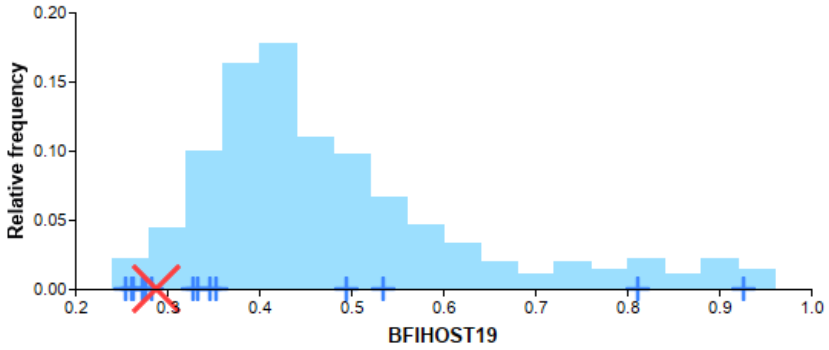


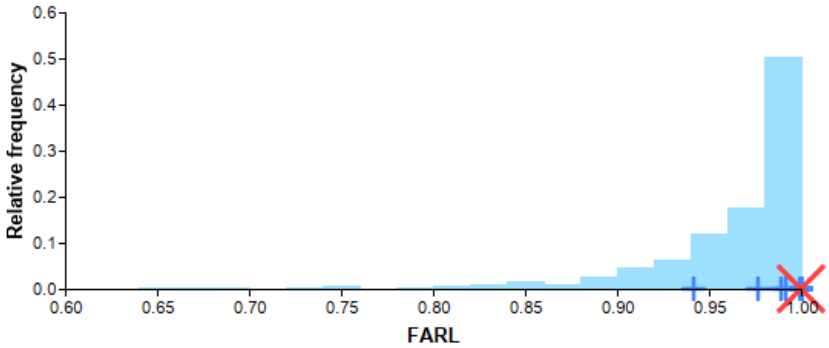
UK Design Flood Estimation

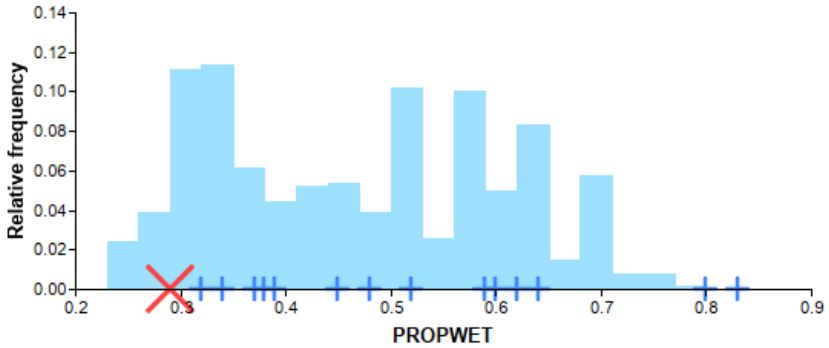
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



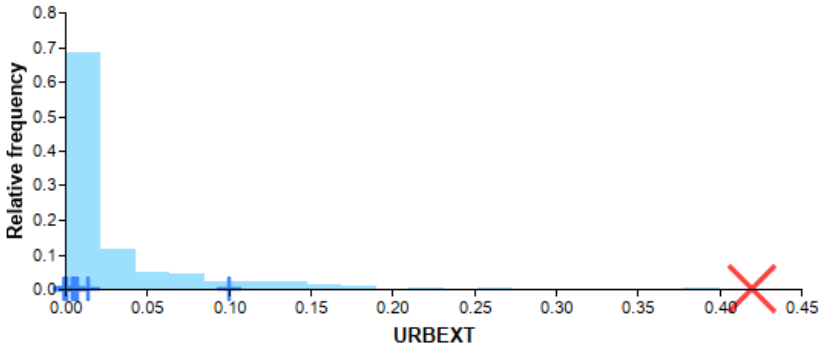


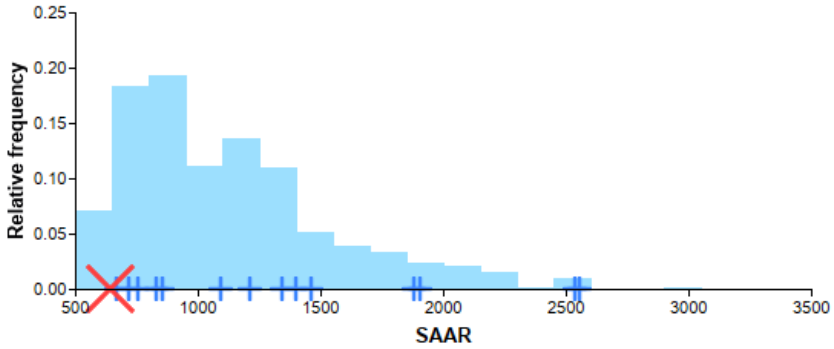


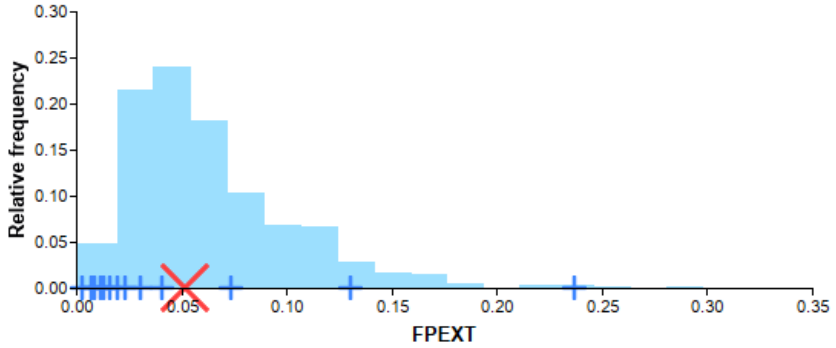


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







Appendix 2 - ReFH2 Calculation Logs

UK Design Flood Estimation

Generated on 17 March 2025 15:19:06 by Helena.duroe
Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 1F91-B44F

Site name: Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1

Easting: 474300

Northing: 169100

Country: England, Wales or Northern Ireland

Catchment Area (km²): 0.92

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH22 (mm):	51.37	Total runoff (ML):	28.89
Total Rainfall (mm):	49.61	Total flow (ML):	45.64
Peak Rainfall (mm):	17.58	Peak flow (m³/s):	1.95

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	04:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.99	No
ARF (Areal reduction factor)	0.98	No
Seasonality	Summer	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	109.62	No
Cmax (mm)	244.17	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.53	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.03	No
BL (hr)	26.05	No
BR	0.82	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.61	No
Effective URBEXT2000	0.42	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.466	0.000	0.793	0.000	0.019	0.019
00:30:00	2.399	0.000	1.342	0.008	0.019	0.027
01:00:00	4.140	0.000	2.361	0.037	0.019	0.056
01:30:00	8.009	0.000	4.731	0.104	0.019	0.123
02:00:00	17.583	0.000	11.137	0.242	0.020	0.262
02:30:00	8.009	0.000	5.415	0.525	0.022	0.547
03:00:00	4.140	0.000	2.883	0.939	0.027	0.966
03:30:00	2.399	0.000	1.697	1.377	0.035	1.412
04:00:00	1.466	0.000	1.046	1.743	0.046	1.789
04:30:00	0.000	0.000	0.000	1.889	0.061	1.950
05:00:00	0.000	0.000	0.000	1.825	0.077	1.902
05:30:00	0.000	0.000	0.000	1.628	0.094	1.721
06:00:00	0.000	0.000	0.000	1.378	0.109	1.487
06:30:00	0.000	0.000	0.000	1.134	0.122	1.257
07:00:00	0.000	0.000	0.000	0.910	0.133	1.043
07:30:00	0.000	0.000	0.000	0.711	0.141	0.852
08:00:00	0.000	0.000	0.000	0.538	0.148	0.685
08:30:00	0.000	0.000	0.000	0.385	0.153	0.538
09:00:00	0.000	0.000	0.000	0.257	0.156	0.413
09:30:00	0.000	0.000	0.000	0.170	0.158	0.328
10:00:00	0.000	0.000	0.000	0.112	0.159	0.271
10:30:00	0.000	0.000	0.000	0.070	0.159	0.229
11:00:00	0.000	0.000	0.000	0.038	0.158	0.196
11:30:00	0.000	0.000	0.000	0.018	0.156	0.174
12:00:00	0.000	0.000	0.000	0.008	0.154	0.162
12:30:00	0.000	0.000	0.000	0.003	0.151	0.154
13:00:00	0.000	0.000	0.000	0.001	0.148	0.149
13:30:00	0.000	0.000	0.000	0.000	0.145	0.145
14:00:00	0.000	0.000	0.000	0.000	0.142	0.142
14:30:00	0.000	0.000	0.000	0.000	0.140	0.140
15:00:00	0.000	0.000	0.000	0.000	0.137	0.137
15:30:00	0.000	0.000	0.000	0.000	0.134	0.134
16:00:00	0.000	0.000	0.000	0.000	0.132	0.132
16:30:00	0.000	0.000	0.000	0.000	0.129	0.129

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.000	0.000	0.000	0.000	0.127	0.127
17:30:00	0.000	0.000	0.000	0.000	0.125	0.125
18:00:00	0.000	0.000	0.000	0.000	0.122	0.122
18:30:00	0.000	0.000	0.000	0.000	0.120	0.120
19:00:00	0.000	0.000	0.000	0.000	0.118	0.118
19:30:00	0.000	0.000	0.000	0.000	0.115	0.115
20:00:00	0.000	0.000	0.000	0.000	0.113	0.113
20:30:00	0.000	0.000	0.000	0.000	0.111	0.111
21:00:00	0.000	0.000	0.000	0.000	0.109	0.109
21:30:00	0.000	0.000	0.000	0.000	0.107	0.107
22:00:00	0.000	0.000	0.000	0.000	0.105	0.105
22:30:00	0.000	0.000	0.000	0.000	0.103	0.103
23:00:00	0.000	0.000	0.000	0.000	0.101	0.101
23:30:00	0.000	0.000	0.000	0.000	0.099	0.099
24:00:00	0.000	0.000	0.000	0.000	0.097	0.097
24:30:00	0.000	0.000	0.000	0.000	0.095	0.095
25:00:00	0.000	0.000	0.000	0.000	0.093	0.093
25:30:00	0.000	0.000	0.000	0.000	0.092	0.092
26:00:00	0.000	0.000	0.000	0.000	0.090	0.090
26:30:00	0.000	0.000	0.000	0.000	0.088	0.088
27:00:00	0.000	0.000	0.000	0.000	0.086	0.086
27:30:00	0.000	0.000	0.000	0.000	0.085	0.085
28:00:00	0.000	0.000	0.000	0.000	0.083	0.083
28:30:00	0.000	0.000	0.000	0.000	0.082	0.082
29:00:00	0.000	0.000	0.000	0.000	0.080	0.080
29:30:00	0.000	0.000	0.000	0.000	0.079	0.079
30:00:00	0.000	0.000	0.000	0.000	0.077	0.077
30:30:00	0.000	0.000	0.000	0.000	0.076	0.076
31:00:00	0.000	0.000	0.000	0.000	0.074	0.074
31:30:00	0.000	0.000	0.000	0.000	0.073	0.073
32:00:00	0.000	0.000	0.000	0.000	0.071	0.071
32:30:00	0.000	0.000	0.000	0.000	0.070	0.070
33:00:00	0.000	0.000	0.000	0.000	0.069	0.069
33:30:00	0.000	0.000	0.000	0.000	0.067	0.067
34:00:00	0.000	0.000	0.000	0.000	0.066	0.066

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
34:30:00	0.000	0.000	0.000	0.000	0.065	0.065
35:00:00	0.000	0.000	0.000	0.000	0.064	0.064
35:30:00	0.000	0.000	0.000	0.000	0.062	0.062
36:00:00	0.000	0.000	0.000	0.000	0.061	0.061
36:30:00	0.000	0.000	0.000	0.000	0.060	0.060
37:00:00	0.000	0.000	0.000	0.000	0.059	0.059
37:30:00	0.000	0.000	0.000	0.000	0.058	0.058
38:00:00	0.000	0.000	0.000	0.000	0.057	0.057
38:30:00	0.000	0.000	0.000	0.000	0.056	0.056
39:00:00	0.000	0.000	0.000	0.000	0.055	0.055
39:30:00	0.000	0.000	0.000	0.000	0.054	0.054
40:00:00	0.000	0.000	0.000	0.000	0.053	0.053
40:30:00	0.000	0.000	0.000	0.000	0.052	0.052
41:00:00	0.000	0.000	0.000	0.000	0.051	0.051
41:30:00	0.000	0.000	0.000	0.000	0.050	0.050
42:00:00	0.000	0.000	0.000	0.000	0.049	0.049
42:30:00	0.000	0.000	0.000	0.000	0.048	0.048
43:00:00	0.000	0.000	0.000	0.000	0.047	0.047
43:30:00	0.000	0.000	0.000	0.000	0.046	0.046
44:00:00	0.000	0.000	0.000	0.000	0.045	0.045
44:30:00	0.000	0.000	0.000	0.000	0.044	0.044
45:00:00	0.000	0.000	0.000	0.000	0.043	0.043
45:30:00	0.000	0.000	0.000	0.000	0.043	0.043
46:00:00	0.000	0.000	0.000	0.000	0.042	0.042
46:30:00	0.000	0.000	0.000	0.000	0.041	0.041
47:00:00	0.000	0.000	0.000	0.000	0.040	0.040
47:30:00	0.000	0.000	0.000	0.000	0.039	0.039
48:00:00	0.000	0.000	0.000	0.000	0.039	0.039
48:30:00	0.000	0.000	0.000	0.000	0.038	0.038
49:00:00	0.000	0.000	0.000	0.000	0.037	0.037
49:30:00	0.000	0.000	0.000	0.000	0.036	0.036
50:00:00	0.000	0.000	0.000	0.000	0.036	0.036
50:30:00	0.000	0.000	0.000	0.000	0.035	0.035
51:00:00	0.000	0.000	0.000	0.000	0.034	0.034
51:30:00	0.000	0.000	0.000	0.000	0.034	0.034

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
52:00:00	0.000	0.000	0.000	0.000	0.033	0.033
52:30:00	0.000	0.000	0.000	0.000	0.032	0.032
53:00:00	0.000	0.000	0.000	0.000	0.032	0.032
53:30:00	0.000	0.000	0.000	0.000	0.031	0.031
54:00:00	0.000	0.000	0.000	0.000	0.031	0.031
54:30:00	0.000	0.000	0.000	0.000	0.030	0.030
55:00:00	0.000	0.000	0.000	0.000	0.030	0.030
55:30:00	0.000	0.000	0.000	0.000	0.029	0.029
56:00:00	0.000	0.000	0.000	0.000	0.028	0.028
56:30:00	0.000	0.000	0.000	0.000	0.028	0.028
57:00:00	0.000	0.000	0.000	0.000	0.027	0.027
57:30:00	0.000	0.000	0.000	0.000	0.027	0.027
58:00:00	0.000	0.000	0.000	0.000	0.026	0.026
58:30:00	0.000	0.000	0.000	0.000	0.026	0.026
59:00:00	0.000	0.000	0.000	0.000	0.025	0.025
59:30:00	0.000	0.000	0.000	0.000	0.025	0.025
60:00:00	0.000	0.000	0.000	0.000	0.024	0.024
60:30:00	0.000	0.000	0.000	0.000	0.024	0.024
61:00:00	0.000	0.000	0.000	0.000	0.023	0.023
61:30:00	0.000	0.000	0.000	0.000	0.023	0.023
62:00:00	0.000	0.000	0.000	0.000	0.023	0.023
62:30:00	0.000	0.000	0.000	0.000	0.022	0.022
63:00:00	0.000	0.000	0.000	0.000	0.022	0.022
63:30:00	0.000	0.000	0.000	0.000	0.021	0.021
64:00:00	0.000	0.000	0.000	0.000	0.021	0.021
64:30:00	0.000	0.000	0.000	0.000	0.020	0.020
65:00:00	0.000	0.000	0.000	0.000	0.020	0.020
65:30:00	0.000	0.000	0.000	0.000	0.020	0.020
66:00:00	0.000	0.000	0.000	0.000	0.019	0.019

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	0.92	No
ALTBAR	68	No
ASPBAR	126	No
ASPVAR	0.7	No
BFIHOST	0.26	No
BFIHOST19	0.29	No
DPLBAR (km)	1.06	No
DPSBAR (mkm^{-1})	39.2	No
FARL	1	No
LDP	1.91	No
PROPWET	0.29	No
RMED1H	11.6	No
RMED1D	29.9	No
RMED2D	36.8	No
SAAR (mm)	642	No
SAAR4170 (mm)	650	No
SPRHOST	44.82	No
URBEXT2000	0.42	No
URBEXT1990	0.22	No
URBCONC	0.9	No
URBLOC	1.14	No
DDF parameter C	-0.03	No
DDF parameter D1	0.28	No
DDF parameter D2	0.27	No
DDF parameter D3	0.33	No
DDF parameter E	0.31	No
DDF parameter F	2.6	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.27	No
DDF parameter D2 (1km grid value)	0.27	No
DDF parameter D3 (1km grid value)	0.33	No
DDF parameter E (1km grid value)	0.31	No
DDF parameter F (1km grid value)	2.6	No

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

UK Design Flood Estimation

Generated on 17 March 2025 15:19:21 by Helena.duroe
Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 1F91-B44F

Site name: Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1

Easting: 474300

Northing: 169100

Country: England, Wales or Northern Ireland

Catchment Area (km²): 0.92

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH22 (mm):	64.73	Total runoff (ML):	37.65
Total Rainfall (mm):	62.51	Total flow (ML):	57.49
Peak Rainfall (mm):	22.15	Peak flow (m³/s):	2.53

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	04:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.99	No
ARF (Areal reduction factor)	0.98	No
Seasonality	Summer	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	109.62	No
Cmax (mm)	244.17	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.53	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.03	No
BL (hr)	26.05	No
BR	0.73	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.61	No
Effective URBEXT2000	0.42	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.847	0.000	1.004	0.000	0.019	0.019
00:30:00	3.023	0.000	1.698	0.010	0.019	0.029
01:00:00	5.216	0.000	3.002	0.047	0.019	0.066
01:30:00	10.091	0.000	6.065	0.132	0.019	0.151
02:00:00	22.153	0.000	14.509	0.308	0.020	0.327
02:30:00	10.091	0.000	7.152	0.671	0.023	0.693
03:00:00	5.216	0.000	3.830	1.208	0.028	1.236
03:30:00	3.023	0.000	2.261	1.778	0.038	1.815
04:00:00	1.847	0.000	1.397	2.259	0.051	2.310
04:30:00	0.000	0.000	0.000	2.457	0.069	2.526
05:00:00	0.000	0.000	0.000	2.380	0.088	2.469
05:30:00	0.000	0.000	0.000	2.128	0.108	2.236
06:00:00	0.000	0.000	0.000	1.804	0.126	1.930
06:30:00	0.000	0.000	0.000	1.487	0.142	1.629
07:00:00	0.000	0.000	0.000	1.194	0.155	1.349
07:30:00	0.000	0.000	0.000	0.933	0.165	1.098
08:00:00	0.000	0.000	0.000	0.707	0.173	0.880
08:30:00	0.000	0.000	0.000	0.508	0.178	0.687
09:00:00	0.000	0.000	0.000	0.340	0.183	0.523
09:30:00	0.000	0.000	0.000	0.226	0.185	0.411
10:00:00	0.000	0.000	0.000	0.149	0.186	0.336
10:30:00	0.000	0.000	0.000	0.093	0.186	0.280
11:00:00	0.000	0.000	0.000	0.052	0.185	0.237
11:30:00	0.000	0.000	0.000	0.025	0.183	0.208
12:00:00	0.000	0.000	0.000	0.011	0.180	0.191
12:30:00	0.000	0.000	0.000	0.004	0.177	0.181
13:00:00	0.000	0.000	0.000	0.001	0.173	0.175
13:30:00	0.000	0.000	0.000	0.000	0.170	0.170
14:00:00	0.000	0.000	0.000	0.000	0.167	0.167
14:30:00	0.000	0.000	0.000	0.000	0.164	0.164
15:00:00	0.000	0.000	0.000	0.000	0.161	0.161
15:30:00	0.000	0.000	0.000	0.000	0.158	0.158
16:00:00	0.000	0.000	0.000	0.000	0.155	0.155
16:30:00	0.000	0.000	0.000	0.000	0.152	0.152

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.000	0.000	0.000	0.000	0.149	0.149
17:30:00	0.000	0.000	0.000	0.000	0.146	0.146
18:00:00	0.000	0.000	0.000	0.000	0.143	0.143
18:30:00	0.000	0.000	0.000	0.000	0.140	0.140
19:00:00	0.000	0.000	0.000	0.000	0.138	0.138
19:30:00	0.000	0.000	0.000	0.000	0.135	0.135
20:00:00	0.000	0.000	0.000	0.000	0.133	0.133
20:30:00	0.000	0.000	0.000	0.000	0.130	0.130
21:00:00	0.000	0.000	0.000	0.000	0.128	0.128
21:30:00	0.000	0.000	0.000	0.000	0.125	0.125
22:00:00	0.000	0.000	0.000	0.000	0.123	0.123
22:30:00	0.000	0.000	0.000	0.000	0.120	0.120
23:00:00	0.000	0.000	0.000	0.000	0.118	0.118
23:30:00	0.000	0.000	0.000	0.000	0.116	0.116
24:00:00	0.000	0.000	0.000	0.000	0.114	0.114
24:30:00	0.000	0.000	0.000	0.000	0.112	0.112
25:00:00	0.000	0.000	0.000	0.000	0.109	0.109
25:30:00	0.000	0.000	0.000	0.000	0.107	0.107
26:00:00	0.000	0.000	0.000	0.000	0.105	0.105
26:30:00	0.000	0.000	0.000	0.000	0.103	0.103
27:00:00	0.000	0.000	0.000	0.000	0.101	0.101
27:30:00	0.000	0.000	0.000	0.000	0.099	0.099
28:00:00	0.000	0.000	0.000	0.000	0.098	0.098
28:30:00	0.000	0.000	0.000	0.000	0.096	0.096
29:00:00	0.000	0.000	0.000	0.000	0.094	0.094
29:30:00	0.000	0.000	0.000	0.000	0.092	0.092
30:00:00	0.000	0.000	0.000	0.000	0.090	0.090
30:30:00	0.000	0.000	0.000	0.000	0.089	0.089
31:00:00	0.000	0.000	0.000	0.000	0.087	0.087
31:30:00	0.000	0.000	0.000	0.000	0.085	0.085
32:00:00	0.000	0.000	0.000	0.000	0.084	0.084
32:30:00	0.000	0.000	0.000	0.000	0.082	0.082
33:00:00	0.000	0.000	0.000	0.000	0.081	0.081
33:30:00	0.000	0.000	0.000	0.000	0.079	0.079
34:00:00	0.000	0.000	0.000	0.000	0.077	0.077

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
34:30:00	0.000	0.000	0.000	0.000	0.076	0.076
35:00:00	0.000	0.000	0.000	0.000	0.075	0.075
35:30:00	0.000	0.000	0.000	0.000	0.073	0.073
36:00:00	0.000	0.000	0.000	0.000	0.072	0.072
36:30:00	0.000	0.000	0.000	0.000	0.070	0.070
37:00:00	0.000	0.000	0.000	0.000	0.069	0.069
37:30:00	0.000	0.000	0.000	0.000	0.068	0.068
38:00:00	0.000	0.000	0.000	0.000	0.066	0.066
38:30:00	0.000	0.000	0.000	0.000	0.065	0.065
39:00:00	0.000	0.000	0.000	0.000	0.064	0.064
39:30:00	0.000	0.000	0.000	0.000	0.063	0.063
40:00:00	0.000	0.000	0.000	0.000	0.062	0.062
40:30:00	0.000	0.000	0.000	0.000	0.060	0.060
41:00:00	0.000	0.000	0.000	0.000	0.059	0.059
41:30:00	0.000	0.000	0.000	0.000	0.058	0.058
42:00:00	0.000	0.000	0.000	0.000	0.057	0.057
42:30:00	0.000	0.000	0.000	0.000	0.056	0.056
43:00:00	0.000	0.000	0.000	0.000	0.055	0.055
43:30:00	0.000	0.000	0.000	0.000	0.054	0.054
44:00:00	0.000	0.000	0.000	0.000	0.053	0.053
44:30:00	0.000	0.000	0.000	0.000	0.052	0.052
45:00:00	0.000	0.000	0.000	0.000	0.051	0.051
45:30:00	0.000	0.000	0.000	0.000	0.050	0.050
46:00:00	0.000	0.000	0.000	0.000	0.049	0.049
46:30:00	0.000	0.000	0.000	0.000	0.048	0.048
47:00:00	0.000	0.000	0.000	0.000	0.047	0.047
47:30:00	0.000	0.000	0.000	0.000	0.046	0.046
48:00:00	0.000	0.000	0.000	0.000	0.045	0.045
48:30:00	0.000	0.000	0.000	0.000	0.044	0.044
49:00:00	0.000	0.000	0.000	0.000	0.044	0.044
49:30:00	0.000	0.000	0.000	0.000	0.043	0.043
50:00:00	0.000	0.000	0.000	0.000	0.042	0.042
50:30:00	0.000	0.000	0.000	0.000	0.041	0.041
51:00:00	0.000	0.000	0.000	0.000	0.040	0.040
51:30:00	0.000	0.000	0.000	0.000	0.040	0.040

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
52:00:00	0.000	0.000	0.000	0.000	0.039	0.039
52:30:00	0.000	0.000	0.000	0.000	0.038	0.038
53:00:00	0.000	0.000	0.000	0.000	0.037	0.037
53:30:00	0.000	0.000	0.000	0.000	0.037	0.037
54:00:00	0.000	0.000	0.000	0.000	0.036	0.036
54:30:00	0.000	0.000	0.000	0.000	0.035	0.035
55:00:00	0.000	0.000	0.000	0.000	0.035	0.035
55:30:00	0.000	0.000	0.000	0.000	0.034	0.034
56:00:00	0.000	0.000	0.000	0.000	0.033	0.033
56:30:00	0.000	0.000	0.000	0.000	0.033	0.033
57:00:00	0.000	0.000	0.000	0.000	0.032	0.032
57:30:00	0.000	0.000	0.000	0.000	0.031	0.031
58:00:00	0.000	0.000	0.000	0.000	0.031	0.031
58:30:00	0.000	0.000	0.000	0.000	0.030	0.030
59:00:00	0.000	0.000	0.000	0.000	0.030	0.030
59:30:00	0.000	0.000	0.000	0.000	0.029	0.029
60:00:00	0.000	0.000	0.000	0.000	0.029	0.029
60:30:00	0.000	0.000	0.000	0.000	0.028	0.028
61:00:00	0.000	0.000	0.000	0.000	0.027	0.027
61:30:00	0.000	0.000	0.000	0.000	0.027	0.027
62:00:00	0.000	0.000	0.000	0.000	0.026	0.026
62:30:00	0.000	0.000	0.000	0.000	0.026	0.026
63:00:00	0.000	0.000	0.000	0.000	0.025	0.025
63:30:00	0.000	0.000	0.000	0.000	0.025	0.025
64:00:00	0.000	0.000	0.000	0.000	0.024	0.024
64:30:00	0.000	0.000	0.000	0.000	0.024	0.024
65:00:00	0.000	0.000	0.000	0.000	0.024	0.024
65:30:00	0.000	0.000	0.000	0.000	0.023	0.023
66:00:00	0.000	0.000	0.000	0.000	0.023	0.023
66:30:00	0.000	0.000	0.000	0.000	0.022	0.022
67:00:00	0.000	0.000	0.000	0.000	0.022	0.022
67:30:00	0.000	0.000	0.000	0.000	0.021	0.021
68:00:00	0.000	0.000	0.000	0.000	0.021	0.021
68:30:00	0.000	0.000	0.000	0.000	0.021	0.021
69:00:00	0.000	0.000	0.000	0.000	0.020	0.020

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
69:30:00	0.000	0.000	0.000	0.000	0.020	0.020
70:00:00	0.000	0.000	0.000	0.000	0.019	0.019

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	0.92	No
ALTBAR	68	No
ASPBAR	126	No
ASPVAR	0.7	No
BFIHOST	0.26	No
BFIHOST19	0.29	No
DPLBAR (km)	1.06	No
DPSBAR (mkm-¹)	39.2	No
FARL	1	No
LDP	1.91	No
PROPWET	0.29	No
RMED1H	11.6	No
RMED1D	29.9	No
RMED2D	36.8	No
SAAR (mm)	642	No
SAAR4170 (mm)	650	No
SPRHOST	44.82	No
URBEXT2000	0.42	No
URBEXT1990	0.22	No
URBCONC	0.9	No
URBLOC	1.14	No
DDF parameter C	-0.03	No
DDF parameter D1	0.28	No
DDF parameter D2	0.27	No
DDF parameter D3	0.33	No
DDF parameter E	0.31	No
DDF parameter F	2.6	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.27	No
DDF parameter D2 (1km grid value)	0.27	No
DDF parameter D3 (1km grid value)	0.33	No
DDF parameter E (1km grid value)	0.31	No
DDF parameter F (1km grid value)	2.6	No

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

UK Design Flood Estimation

Generated on 17 March 2025 15:19:40 by Helena.duroe
Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 1F91-B44F

Site name: Updated URBEXT_FEH_Catchment_Descriptors_474300_169100_v5_0_1

Easting: 474300

Northing: 169100

Country: England, Wales or Northern Ireland

Catchment Area (km²): 0.92

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 1000 year

Summary of results

Rainfall - FEH22 (mm):	98.35	Total runoff (ML):	61.95
Total Rainfall (mm):	94.97	Total flow (ML):	87.36
Peak Rainfall (mm):	33.66	Peak flow (m³/s):	4.11

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	04:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.99	No
ARF (Areal reduction factor)	0.98	No
Seasonality	Summer	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	109.62	No
Cmax (mm)	244.17	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.53	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.03	No
BL (hr)	26.05	No
BR	0.55	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.61	No
Effective URBEXT2000	0.42	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	2.806	0.000	1.540	0.000	0.019	0.019
00:30:00	4.593	0.000	2.607	0.016	0.019	0.034
01:00:00	7.925	0.000	4.664	0.073	0.019	0.092
01:30:00	15.333	0.000	9.619	0.203	0.019	0.222
02:00:00	33.660	0.000	23.870	0.476	0.020	0.497
02:30:00	15.333	0.000	12.128	1.055	0.024	1.079
03:00:00	7.925	0.000	6.577	1.927	0.031	1.957
03:30:00	4.593	0.000	3.907	2.865	0.043	2.908
04:00:00	2.806	0.000	2.422	3.673	0.060	3.733
04:30:00	0.000	0.000	0.000	4.028	0.082	4.109
05:00:00	0.000	0.000	0.000	3.928	0.107	4.034
05:30:00	0.000	0.000	0.000	3.528	0.132	3.660
06:00:00	0.000	0.000	0.000	3.003	0.156	3.158
06:30:00	0.000	0.000	0.000	2.480	0.176	2.656
07:00:00	0.000	0.000	0.000	1.995	0.193	2.188
07:30:00	0.000	0.000	0.000	1.563	0.206	1.769
08:00:00	0.000	0.000	0.000	1.189	0.216	1.405
08:30:00	0.000	0.000	0.000	0.860	0.224	1.084
09:00:00	0.000	0.000	0.000	0.579	0.230	0.809
09:30:00	0.000	0.000	0.000	0.387	0.233	0.621
10:00:00	0.000	0.000	0.000	0.258	0.235	0.493
10:30:00	0.000	0.000	0.000	0.163	0.235	0.398
11:00:00	0.000	0.000	0.000	0.091	0.234	0.325
11:30:00	0.000	0.000	0.000	0.044	0.231	0.275
12:00:00	0.000	0.000	0.000	0.020	0.227	0.248
12:30:00	0.000	0.000	0.000	0.008	0.223	0.231
13:00:00	0.000	0.000	0.000	0.002	0.219	0.221
13:30:00	0.000	0.000	0.000	0.000	0.215	0.215
14:00:00	0.000	0.000	0.000	0.000	0.211	0.211
14:30:00	0.000	0.000	0.000	0.000	0.207	0.207
15:00:00	0.000	0.000	0.000	0.000	0.203	0.203
15:30:00	0.000	0.000	0.000	0.000	0.199	0.199
16:00:00	0.000	0.000	0.000	0.000	0.195	0.195
16:30:00	0.000	0.000	0.000	0.000	0.192	0.192

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:00:00	0.000	0.000	0.000	0.000	0.188	0.188
17:30:00	0.000	0.000	0.000	0.000	0.184	0.184
18:00:00	0.000	0.000	0.000	0.000	0.181	0.181
18:30:00	0.000	0.000	0.000	0.000	0.178	0.178
19:00:00	0.000	0.000	0.000	0.000	0.174	0.174
19:30:00	0.000	0.000	0.000	0.000	0.171	0.171
20:00:00	0.000	0.000	0.000	0.000	0.168	0.168
20:30:00	0.000	0.000	0.000	0.000	0.164	0.164
21:00:00	0.000	0.000	0.000	0.000	0.161	0.161
21:30:00	0.000	0.000	0.000	0.000	0.158	0.158
22:00:00	0.000	0.000	0.000	0.000	0.155	0.155
22:30:00	0.000	0.000	0.000	0.000	0.152	0.152
23:00:00	0.000	0.000	0.000	0.000	0.149	0.149
23:30:00	0.000	0.000	0.000	0.000	0.147	0.147
24:00:00	0.000	0.000	0.000	0.000	0.144	0.144
24:30:00	0.000	0.000	0.000	0.000	0.141	0.141
25:00:00	0.000	0.000	0.000	0.000	0.138	0.138
25:30:00	0.000	0.000	0.000	0.000	0.136	0.136
26:00:00	0.000	0.000	0.000	0.000	0.133	0.133
26:30:00	0.000	0.000	0.000	0.000	0.131	0.131
27:00:00	0.000	0.000	0.000	0.000	0.128	0.128
27:30:00	0.000	0.000	0.000	0.000	0.126	0.126
28:00:00	0.000	0.000	0.000	0.000	0.123	0.123
28:30:00	0.000	0.000	0.000	0.000	0.121	0.121
29:00:00	0.000	0.000	0.000	0.000	0.119	0.119
29:30:00	0.000	0.000	0.000	0.000	0.116	0.116
30:00:00	0.000	0.000	0.000	0.000	0.114	0.114
30:30:00	0.000	0.000	0.000	0.000	0.112	0.112
31:00:00	0.000	0.000	0.000	0.000	0.110	0.110
31:30:00	0.000	0.000	0.000	0.000	0.108	0.108
32:00:00	0.000	0.000	0.000	0.000	0.106	0.106
32:30:00	0.000	0.000	0.000	0.000	0.104	0.104
33:00:00	0.000	0.000	0.000	0.000	0.102	0.102
33:30:00	0.000	0.000	0.000	0.000	0.100	0.100
34:00:00	0.000	0.000	0.000	0.000	0.098	0.098

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
34:30:00	0.000	0.000	0.000	0.000	0.096	0.096
35:00:00	0.000	0.000	0.000	0.000	0.094	0.094
35:30:00	0.000	0.000	0.000	0.000	0.092	0.092
36:00:00	0.000	0.000	0.000	0.000	0.091	0.091
36:30:00	0.000	0.000	0.000	0.000	0.089	0.089
37:00:00	0.000	0.000	0.000	0.000	0.087	0.087
37:30:00	0.000	0.000	0.000	0.000	0.086	0.086
38:00:00	0.000	0.000	0.000	0.000	0.084	0.084
38:30:00	0.000	0.000	0.000	0.000	0.082	0.082
39:00:00	0.000	0.000	0.000	0.000	0.081	0.081
39:30:00	0.000	0.000	0.000	0.000	0.079	0.079
40:00:00	0.000	0.000	0.000	0.000	0.078	0.078
40:30:00	0.000	0.000	0.000	0.000	0.076	0.076
41:00:00	0.000	0.000	0.000	0.000	0.075	0.075
41:30:00	0.000	0.000	0.000	0.000	0.073	0.073
42:00:00	0.000	0.000	0.000	0.000	0.072	0.072
42:30:00	0.000	0.000	0.000	0.000	0.071	0.071
43:00:00	0.000	0.000	0.000	0.000	0.069	0.069
43:30:00	0.000	0.000	0.000	0.000	0.068	0.068
44:00:00	0.000	0.000	0.000	0.000	0.067	0.067
44:30:00	0.000	0.000	0.000	0.000	0.065	0.065
45:00:00	0.000	0.000	0.000	0.000	0.064	0.064
45:30:00	0.000	0.000	0.000	0.000	0.063	0.063
46:00:00	0.000	0.000	0.000	0.000	0.062	0.062
46:30:00	0.000	0.000	0.000	0.000	0.061	0.061
47:00:00	0.000	0.000	0.000	0.000	0.059	0.059
47:30:00	0.000	0.000	0.000	0.000	0.058	0.058
48:00:00	0.000	0.000	0.000	0.000	0.057	0.057
48:30:00	0.000	0.000	0.000	0.000	0.056	0.056
49:00:00	0.000	0.000	0.000	0.000	0.055	0.055
49:30:00	0.000	0.000	0.000	0.000	0.054	0.054
50:00:00	0.000	0.000	0.000	0.000	0.053	0.053
50:30:00	0.000	0.000	0.000	0.000	0.052	0.052
51:00:00	0.000	0.000	0.000	0.000	0.051	0.051
51:30:00	0.000	0.000	0.000	0.000	0.050	0.050

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
52:00:00	0.000	0.000	0.000	0.000	0.049	0.049
52:30:00	0.000	0.000	0.000	0.000	0.048	0.048
53:00:00	0.000	0.000	0.000	0.000	0.047	0.047
53:30:00	0.000	0.000	0.000	0.000	0.046	0.046
54:00:00	0.000	0.000	0.000	0.000	0.045	0.045
54:30:00	0.000	0.000	0.000	0.000	0.045	0.045
55:00:00	0.000	0.000	0.000	0.000	0.044	0.044
55:30:00	0.000	0.000	0.000	0.000	0.043	0.043
56:00:00	0.000	0.000	0.000	0.000	0.042	0.042
56:30:00	0.000	0.000	0.000	0.000	0.041	0.041
57:00:00	0.000	0.000	0.000	0.000	0.040	0.040
57:30:00	0.000	0.000	0.000	0.000	0.040	0.040
58:00:00	0.000	0.000	0.000	0.000	0.039	0.039
58:30:00	0.000	0.000	0.000	0.000	0.038	0.038
59:00:00	0.000	0.000	0.000	0.000	0.037	0.037
59:30:00	0.000	0.000	0.000	0.000	0.037	0.037
60:00:00	0.000	0.000	0.000	0.000	0.036	0.036
60:30:00	0.000	0.000	0.000	0.000	0.035	0.035
61:00:00	0.000	0.000	0.000	0.000	0.035	0.035
61:30:00	0.000	0.000	0.000	0.000	0.034	0.034
62:00:00	0.000	0.000	0.000	0.000	0.033	0.033
62:30:00	0.000	0.000	0.000	0.000	0.033	0.033
63:00:00	0.000	0.000	0.000	0.000	0.032	0.032
63:30:00	0.000	0.000	0.000	0.000	0.032	0.032
64:00:00	0.000	0.000	0.000	0.000	0.031	0.031
64:30:00	0.000	0.000	0.000	0.000	0.030	0.030
65:00:00	0.000	0.000	0.000	0.000	0.030	0.030
65:30:00	0.000	0.000	0.000	0.000	0.029	0.029
66:00:00	0.000	0.000	0.000	0.000	0.029	0.029
66:30:00	0.000	0.000	0.000	0.000	0.028	0.028
67:00:00	0.000	0.000	0.000	0.000	0.028	0.028
67:30:00	0.000	0.000	0.000	0.000	0.027	0.027
68:00:00	0.000	0.000	0.000	0.000	0.027	0.027
68:30:00	0.000	0.000	0.000	0.000	0.026	0.026
69:00:00	0.000	0.000	0.000	0.000	0.026	0.026

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
69:30:00	0.000	0.000	0.000	0.000	0.025	0.025
70:00:00	0.000	0.000	0.000	0.000	0.025	0.025
70:30:00	0.000	0.000	0.000	0.000	0.024	0.024
71:00:00	0.000	0.000	0.000	0.000	0.024	0.024
71:30:00	0.000	0.000	0.000	0.000	0.023	0.023
72:00:00	0.000	0.000	0.000	0.000	0.023	0.023
72:30:00	0.000	0.000	0.000	0.000	0.022	0.022
73:00:00	0.000	0.000	0.000	0.000	0.022	0.022
73:30:00	0.000	0.000	0.000	0.000	0.021	0.021
74:00:00	0.000	0.000	0.000	0.000	0.021	0.021
74:30:00	0.000	0.000	0.000	0.000	0.021	0.021
75:00:00	0.000	0.000	0.000	0.000	0.020	0.020
75:30:00	0.000	0.000	0.000	0.000	0.020	0.020
76:00:00	0.000	0.000	0.000	0.000	0.020	0.020

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	0.92	No
ALTBAR	68	No
ASPBAR	126	No
ASPVAR	0.7	No
BFIHOST	0.26	No
BFIHOST19	0.29	No
DPLBAR (km)	1.06	No
DPSBAR (mkm-¹)	39.2	No
FARL	1	No
LDP	1.91	No
PROPWET	0.29	No
RMED1H	11.6	No
RMED1D	29.9	No
RMED2D	36.8	No
SAAR (mm)	642	No
SAAR4170 (mm)	650	No
SPRHOST	44.82	No
URBEXT2000	0.42	No
URBEXT1990	0.22	No
URBCONC	0.9	No
URBLOC	1.14	No
DDF parameter C	-0.03	No
DDF parameter D1	0.28	No
DDF parameter D2	0.27	No
DDF parameter D3	0.33	No
DDF parameter E	0.31	No
DDF parameter F	2.6	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.27	No
DDF parameter D2 (1km grid value)	0.27	No
DDF parameter D3 (1km grid value)	0.33	No
DDF parameter E (1km grid value)	0.31	No
DDF parameter F (1km grid value)	2.6	No

Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Appendix 3 - Full ReFH2 Hydrographs

Time	1-Year	2-Year	5-Year	10-Year	30-Year	50-Year
00:00:00	0.019231261	0.019231261	0.019231261	0.019231261	0.019231261	0.019231261
00:30:00	0.021690263	0.022208159	0.023897994	0.025046048	0.0268727	0.027752596
01:00:00	0.031984158	0.034396723	0.042275372	0.047633987	0.056170051	0.060286314
01:30:00	0.056004592	0.062677617	0.084505164	0.099382267	0.123133188	0.134609317
02:00:00	0.10568862	0.121096745	0.1716578	0.206259033	0.261731694	0.288636844
02:30:00	0.205903721	0.239041592	0.348557703	0.424176448	0.546516643	0.606334175
03:00:00	0.350986112	0.410079449	0.606590696	0.743323567	0.966247169	1.075978894
03:30:00	0.502527715	0.589026978	0.877970586	1.080125869	1.41150967	1.575396705
04:00:00	0.628526047	0.738136152	1.105640968	1.363919582	1.78917555	2.000281607
04:30:00	0.678969586	0.798279054	1.199547573	1.482610559	1.950372873	2.183298229
05:00:00	0.658805904	0.774970429	1.166516177	1.443444328	1.902230549	2.13117596
05:30:00	0.595596967	0.700568342	1.054733271	1.305516816	1.721460341	1.929224549
06:00:00	0.5159355	0.606508907	0.912041727	1.128343413	1.487024328	1.666155953
06:30:00	0.438802217	0.515290618	0.772972437	0.955113129	1.256691877	1.407114791
07:00:00	0.36766379	0.431120093	0.644443711	0.794846182	1.043260159	1.16690701
07:30:00	0.30390946	0.355701681	0.529321481	0.651314293	0.85213669	0.951813375
08:00:00	0.248100645	0.289709915	0.428702663	0.525947876	0.685360036	0.764199332
08:30:00	0.198754456	0.231369708	0.339788219	0.41519066	0.538066566	0.598526628
09:00:00	0.157014531	0.182003022	0.264446868	0.321252098	0.412956468	0.45770927
09:30:00	0.129058371	0.148907885	0.213763101	0.257902523	0.328261537	0.362210201
10:00:00	0.110389096	0.126801687	0.179855756	0.215465061	0.271397511	0.298022736
10:30:00	0.096440663	0.110293921	0.15455517	0.183804453	0.228973174	0.250131174
11:00:00	0.085708777	0.09760192	0.135127558	0.159503555	0.196422524	0.213389273
11:30:00	0.0783595	0.088922609	0.121875749	0.142941762	0.174254659	0.188372117
12:00:00	0.074122095	0.083941989	0.114350701	0.133583645	0.161805657	0.174357817
12:30:00	0.071316316	0.080671332	0.109513908	0.127639754	0.154028394	0.16566592
13:00:00	0.069292006	0.078335649	0.106155082	0.123579573	0.14884193	0.159932399
13:30:00	0.067746481	0.076572612	0.103701087	0.120672558	0.145241531	0.156010017
14:00:00	0.066450998	0.075107835	0.101715245	0.118360077	0.142454989	0.153015118
14:30:00	0.065187568	0.073679813	0.099781337	0.116109702	0.139746498	0.150105848
15:00:00	0.06394816	0.072278942	0.097884199	0.113902114	0.137089504	0.147251892
15:30:00	0.062732316	0.070904706	0.096023131	0.111736498	0.134483028	0.144452199
16:00:00	0.06153959	0.069556598	0.094197448	0.109612057	0.131926108	0.141705735
16:30:00	0.06036954	0.068234121	0.092406476	0.107528007	0.129417802	0.13901149
17:00:00	0.059221737	0.066936789	0.090649556	0.105483582	0.126957188	0.136368471
17:30:00	0.058095757	0.065664123	0.08892604	0.103478028	0.124543356	0.133775703
18:00:00	0.056991185	0.064415654	0.087235293	0.101510604	0.122175419	0.131232232
18:30:00	0.055907614	0.063190922	0.085576692	0.099580588	0.119852503	0.128737119
19:00:00	0.054844645	0.061989476	0.083949626	0.097687267	0.117573753	0.126289446
19:30:00	0.053801886	0.060810872	0.082353496	0.095829943	0.115338328	0.123888311
20:00:00	0.052778953	0.059654678	0.080787712	0.094007932	0.113145406	0.121532828
20:30:00	0.051775469	0.058520466	0.079251699	0.092220564	0.110994177	0.119222129
21:00:00	0.050791064	0.057407819	0.07774489	0.090467178	0.10888385	0.116955364
21:30:00	0.049825376	0.056316327	0.07626673	0.08874713	0.106813646	0.114731697
22:00:00	0.048878049	0.055245587	0.074816674	0.087059785	0.104782803	0.112550309
22:30:00	0.047948732	0.054195205	0.073394188	0.085404521	0.102790572	0.110410394
23:00:00	0.047037085	0.053164794	0.071998748	0.083780728	0.100836219	0.108311167

Time	1-Year	2-Year	5-Year	10-Year	30-Year	50-Year
23:30:00	0.046142771	0.052153974	0.070629839	0.082187809	0.098919025	0.106251851
24:00:00	0.045265461	0.051162373	0.069286957	0.080625176	0.097038282	0.104231689
24:30:00	0.044404831	0.050189625	0.067969607	0.079092253	0.095193297	0.102249937
25:00:00	0.043560563	0.049235372	0.066677304	0.077588476	0.093383391	0.100305863
25:30:00	0.042732348	0.048299262	0.065409571	0.076113289	0.091607897	0.098398753
26:00:00	0.04191988	0.04738095	0.064165942	0.074666151	0.08986616	0.096527901
26:30:00	0.041122859	0.046480098	0.062945958	0.073246527	0.088157539	0.094692621
27:00:00	0.040340992	0.045596374	0.061749169	0.071853894	0.086481404	0.092892234
27:30:00	0.039573991	0.044729453	0.060575135	0.070487739	0.084837136	0.091126078
28:00:00	0.038821572	0.043879013	0.059423422	0.069147558	0.083224132	0.089393502
28:30:00	0.038083459	0.043044744	0.058293607	0.067832859	0.081641795	0.087693867
29:00:00	0.03735938	0.042226336	0.057185274	0.066543156	0.080089543	0.086026548
29:30:00	0.036649068	0.041423488	0.056098013	0.065277974	0.078566804	0.084390929
30:00:00	0.035952261	0.040635906	0.055031424	0.064036847	0.077073017	0.082786408
30:30:00	0.035268702	0.039863297	0.053985114	0.062819317	0.075607631	0.081212394
31:00:00	0.03459814	0.039105378	0.052958697	0.061624936	0.074170107	0.079668306
31:30:00	0.033940327	0.038361869	0.051951796	0.060453264	0.072759914	0.078153576
32:00:00	0.033295021	0.037632496	0.050964038	0.059303869	0.071376533	0.076667646
32:30:00	0.032661984	0.036916991	0.049995061	0.058176327	0.070019454	0.075209967
33:00:00	0.032040983	0.03621509	0.049044508	0.057070223	0.068688177	0.073780003
33:30:00	0.03143179	0.035526534	0.048112027	0.055985149	0.067382212	0.072377227
34:00:00	0.030834178	0.03485107	0.047197275	0.054920706	0.066101077	0.071001122
34:30:00	0.03024793	0.034188448	0.046299915	0.053876501	0.0648443	0.069651181
35:00:00	0.029672827	0.033538425	0.045419617	0.05285215	0.063611418	0.068326906
35:30:00	0.029108659	0.03290076	0.044556056	0.051847274	0.062401977	0.06702781
36:00:00	0.028555217	0.032275219	0.043708913	0.050861504	0.061215531	0.065753413
36:30:00	0.028012298	0.031661572	0.042877878	0.049894477	0.060051643	0.064503246
37:00:00	0.027479702	0.031059592	0.042062643	0.048945835	0.058909884	0.063276849
37:30:00	0.026957231	0.030469057	0.041262907	0.04801523	0.057789833	0.062073769
38:00:00	0.026444695	0.029889751	0.040478378	0.047102319	0.056691077	0.060893563
38:30:00	0.025941903	0.029321458	0.039708764	0.046206764	0.055613212	0.059735797
39:00:00	0.025448671	0.028763971	0.038953783	0.045328237	0.054555841	0.058600043
39:30:00	0.024964816	0.028217082	0.038213156	0.044466413	0.053518573	0.057485883
40:00:00	0.024490161	0.027680592	0.037486611	0.043620976	0.052501027	0.056392906
40:30:00	0.024024531	0.027154302	0.03677388	0.042791612	0.051502827	0.05532071
41:00:00	0.023567754	0.026638019	0.0360747	0.041978017	0.050523606	0.0542689
41:30:00	0.023119661	0.026131551	0.035388813	0.041179891	0.049563003	0.053237088
42:00:00	0.022680088	0.025634713	0.034715967	0.040396939	0.048620664	0.052224893
42:30:00	0.022248872	0.025147322	0.034055914	0.039628874	0.047696241	0.051231944
43:00:00	0.021825855	0.024669197	0.033408411	0.038875412	0.046789395	0.050257873
43:30:00	0.021410881	0.024200162	0.032773218	0.038136276	0.04589979	0.049302323
44:00:00	0.021003797	0.023740046	0.032150102	0.037411192	0.045027099	0.04836494
44:30:00	0.020604453	0.023288677	0.031538834	0.036699895	0.044171001	0.047445379
45:00:00	0.020212701	0.022845891	0.030939187	0.036002121	0.04333118	0.046543302
45:30:00	0.019828398	0.022411523	0.030350942	0.035317615	0.042507326	0.045658377
46:00:00	0.019451402	0.021985414	0.029773881	0.034646122	0.041699136	0.044790276
46:30:00	0	0.021567406	0.029207791	0.033987397	0.040906312	0.04393868

Time	1-Year	2-Year	5-Year	10-Year	30-Year	50-Year
47:00:00	0	0.021157346	0.028652465	0.033341196	0.040128562	0.043103276
47:30:00	0	0.020755082	0.028107697	0.032707282	0.0393656	0.042283755
48:00:00	0	0.020360467	0.027573286	0.03208542	0.038617144	0.041479816
48:30:00	0	0.019973354	0.027049037	0.031475381	0.037882917	0.040691162
49:00:00	0	0.019593602	0.026534755	0.030876941	0.037162651	0.039917503
49:30:00	0	0	0.026030251	0.030289879	0.036456079	0.039158553
50:00:00	0	0	0.025535339	0.029713979	0.035762942	0.038414034
50:30:00	0	0	0.025049836	0.029149028	0.035082982	0.037683669
51:00:00	0	0	0.024573565	0.028594819	0.034415951	0.036967191
51:30:00	0	0	0.024106349	0.028051147	0.033761602	0.036264336
52:00:00	0	0	0.023648016	0.027517812	0.033119694	0.035574844
52:30:00	0	0	0.023198397	0.026994617	0.032489991	0.034898461
53:00:00	0	0	0.022757327	0.02648137	0.03187226	0.034234938
53:30:00	0	0	0.022324643	0.02597788	0.031266274	0.03358403
54:00:00	0	0	0.021900186	0.025483964	0.03067181	0.032945499
54:30:00	0	0	0.021483798	0.024999439	0.030088648	0.032319107
55:00:00	0	0	0.021075328	0.024524125	0.029516574	0.031704626
55:30:00	0	0	0.020674624	0.024057849	0.028955377	0.031101827
56:00:00	0	0	0.020281538	0.023600439	0.02840485	0.030510489
56:30:00	0	0	0.019895926	0.023151724	0.02786479	0.029930395
57:00:00	0	0	0.019517646	0.022711542	0.027334998	0.02936133
57:30:00	0	0	0	0.022279728	0.026815278	0.028803084
58:00:00	0	0	0	0.021856125	0.026305441	0.028255452
58:30:00	0	0	0	0.021440575	0.025805297	0.027718232
59:00:00	0	0	0	0.021032926	0.025314662	0.027191227
59:30:00	0	0	0	0.020633028	0.024833355	0.026674241
60:00:00	0	0	0	0.020240734	0.0243612	0.026167085
60:30:00	0	0	0	0.019855897	0.023898021	0.025669572
61:00:00	0	0	0	0.019478378	0.023443649	0.025181517
61:30:00	0	0	0	0	0.022997916	0.024702742
62:00:00	0	0	0	0	0.022560658	0.02423307
62:30:00	0	0	0	0	0.022131713	0.023772328
63:00:00	0	0	0	0	0.021710924	0.023320345
63:30:00	0	0	0	0	0.021298135	0.022876957
64:00:00	0	0	0	0	0.020893194	0.022441998
64:30:00	0	0	0	0	0.020495953	0.022015309
65:00:00	0	0	0	0	0.020106264	0.021596733
65:30:00	0	0	0	0	0.019723985	0.021186116
66:00:00	0	0	0	0	0.019348974	0.020783305
66:30:00	0	0	0	0	0	0.020388153
67:00:00	0	0	0	0	0	0.020000514
67:30:00	0	0	0	0	0	0.019620245
68:00:00	0	0	0	0	0	0
68:30:00	0	0	0	0	0	0
69:00:00	0	0	0	0	0	0
69:30:00	0	0	0	0	0	0
70:00:00	0	0	0	0	0	0

Time	1-Year	2-Year	5-Year	10-Year	30-Year	50-Year
70:30:00	0	0	0	0	0	0
71:00:00	0	0	0	0	0	0
71:30:00	0	0	0	0	0	0
72:00:00	0	0	0	0	0	0
72:30:00	0	0	0	0	0	0
73:00:00	0	0	0	0	0	0
73:30:00	0	0	0	0	0	0
74:00:00	0	0	0	0	0	0
74:30:00	0	0	0	0	0	0
75:00:00	0	0	0	0	0	0
75:30:00	0	0	0	0	0	0
76:00:00	0	0	0	0	0	0

Time	75-Year	100-Year	200-Year	1000-Year	100-Year+14%CC	100-Year+23%CC
00:00:00	0.019231261	0.019231261	0.019231261	0.019231261	0.021923637	0.023654451
00:30:00	0.028479313	0.029014908	0.03039447	0.034424205	0.033076995	0.035688337
01:00:00	0.06368818	0.066196653	0.072662882	0.091592512	0.075464185	0.081421884
01:30:00	0.144104976	0.151113426	0.169205004	0.222377943	0.172269306	0.185869514
02:00:00	0.310948431	0.327444524	0.370138947	0.496536883	0.373286758	0.402756765
02:30:00	0.656172246	0.693154366	0.789391699	1.078567574	0.790195977	0.85257987
03:00:00	1.167757624	1.236064297	1.414601298	1.957448091	1.409113298	1.520359085
03:30:00	1.712837493	1.815337827	2.084057731	2.907653554	2.069485122	2.232865527
04:00:00	2.177700078	2.310230315	2.658508394	3.732640284	2.633662559	2.841583287
04:30:00	2.379395247	2.526072096	2.912272661	4.109375647	2.879722189	3.107068678
05:00:00	2.324154331	2.468630192	2.84954212	4.034328862	2.814238419	3.036415136
05:30:00	2.104443124	2.235676127	2.581877936	3.660351057	2.548670784	2.749881636
06:00:00	1.817213177	1.930342238	2.228754512	3.158117062	2.200590152	2.374320953
06:30:00	1.533872613	1.628752472	1.878831122	2.65609472	1.856777818	2.003365541
07:00:00	1.270979205	1.348809379	1.553683622	2.188312852	1.537642692	1.659035536
07:30:00	1.035576739	1.098143288	1.262547611	1.769473995	1.251883348	1.350716244
08:00:00	0.830317255	0.879627072	1.008902301	1.405137057	1.002774863	1.081941299
08:30:00	0.649083356	0.686703797	0.785009029	1.083703887	0.782842329	0.84464567
09:00:00	0.49495457	0.522568566	0.59433552	0.809231724	0.595728165	0.642759336
09:30:00	0.390276653	0.410977933	0.464362429	0.620819054	0.468514843	0.505502857
10:00:00	0.31985741	0.335859785	0.376727058	0.4932145	0.382880155	0.413107536
10:30:00	0.267312054	0.279804482	0.311318303	0.397910135	0.318977109	0.344159513
11:00:00	0.22700203	0.236803069	0.261143724	0.324799811	0.269955499	0.291267775
11:30:00	0.199558654	0.207529323	0.226990444	0.275035044	0.236583428	0.255261067
12:00:00	0.184214093	0.191182663	0.207977907	0.247537651	0.217948236	0.235154676
12:30:00	0.174751353	0.181142872	0.19641688	0.2312458	0.206502874	0.222805732
13:00:00	0.168563798	0.174619413	0.189023228	0.22126939	0.199066131	0.214781878
13:30:00	0.164381379	0.170248758	0.184181051	0.215159718	0.194083584	0.209405972
14:00:00	0.161224194	0.166977638	0.180638607	0.211006987	0.190354508	0.205382495
14:30:00	0.158158846	0.1638029	0.177204133	0.206995121	0.186735306	0.201477567
15:00:00	0.155151779	0.160688523	0.173834959	0.203059532	0.183184916	0.197646883
15:30:00	0.152201885	0.157633359	0.170529842	0.19919877	0.179702029	0.193889031
16:00:00	0.149308077	0.154636283	0.167287566	0.195411412	0.176285362	0.190202628
16:30:00	0.146469289	0.15169619	0.164106935	0.191696064	0.172933657	0.186586314
17:00:00	0.143684475	0.148811997	0.160986777	0.188051355	0.169645677	0.183038756
17:30:00	0.140952609	0.145982641	0.157925943	0.184475943	0.166420211	0.179558649
18:00:00	0.138272683	0.14320708	0.154923304	0.18096851	0.163256071	0.176144708
18:30:00	0.135643711	0.14048429	0.151977754	0.177527764	0.16015209	0.172795677
19:00:00	0.133064723	0.137813268	0.149088207	0.174152436	0.157107126	0.16951032
19:30:00	0.130534769	0.135193031	0.1462536	0.170841284	0.154120055	0.166287428
20:00:00	0.128052917	0.132622612	0.143472887	0.167593086	0.151189777	0.163125812
20:30:00	0.125618253	0.130101064	0.140745043	0.164406646	0.148315213	0.160024309
21:00:00	0.123229879	0.127627458	0.138069064	0.16128079	0.145495302	0.156981773
21:30:00	0.120886915	0.125200883	0.135443963	0.158214366	0.142729006	0.153997086
22:00:00	0.118588497	0.122820444	0.132868773	0.155206243	0.140015306	0.151069146
22:30:00	0.116333779	0.120485264	0.130342545	0.152255313	0.137353201	0.148196875
23:00:00	0.11412193	0.118194483	0.127864348	0.14936049	0.134741711	0.145379215

Time	75-Year	100-Year	200-Year	1000-Year	100-Year+14%CC	100-Year+23%CC
23:30:00	0.111952135	0.115947257	0.125433269	0.146520706	0.132179873	0.142615126
24:00:00	0.109823594	0.113742757	0.123048411	0.143734914	0.129666743	0.139903591
24:30:00	0.107735523	0.111580171	0.120708897	0.141002088	0.127201395	0.13724361
25:00:00	0.105687152	0.109458702	0.118413865	0.138321222	0.12478292	0.134634204
25:30:00	0.103677727	0.107377569	0.116162467	0.135691327	0.122410428	0.132074409
26:00:00	0.101706507	0.105336004	0.113953875	0.133111433	0.120083044	0.129563285
26:30:00	0.099772766	0.103333255	0.111787275	0.130580592	0.117799911	0.127099904
27:00:00	0.097875791	0.101368584	0.109661869	0.128097869	0.115560186	0.124683359
27:30:00	0.096014882	0.099441268	0.107576872	0.12566235	0.113363045	0.12231276
28:00:00	0.094189356	0.097550596	0.105531518	0.123273137	0.111207679	0.119987233
28:30:00	0.092398538	0.09569587	0.103525052	0.12092935	0.109093292	0.117705921
29:00:00	0.090641768	0.093876409	0.101556735	0.118630126	0.107019106	0.115467983
29:30:00	0.088918401	0.092091541	0.099625841	0.116374617	0.104984357	0.113272596
30:00:00	0.087227799	0.090340609	0.097731659	0.114161991	0.102988294	0.111118949
30:30:00	0.085569341	0.088622967	0.095873492	0.111991434	0.101030182	0.109006249
31:00:00	0.083942415	0.086937982	0.094050653	0.109862146	0.0991093	0.106933718
31:30:00	0.082346421	0.085285034	0.092262472	0.107773342	0.097224939	0.104900592
32:00:00	0.080780772	0.083663514	0.09050829	0.105724252	0.095376406	0.102906122
32:30:00	0.079244891	0.082072823	0.08878746	0.103714122	0.093563018	0.100949572
33:00:00	0.077738212	0.080512376	0.087099348	0.10174221	0.091784109	0.099030223
33:30:00	0.076260178	0.078981598	0.085443332	0.09980779	0.090039021	0.097147365
34:00:00	0.074810247	0.077479924	0.083818802	0.097910149	0.088327114	0.095300307
34:30:00	0.073387883	0.076006802	0.082225159	0.096048587	0.086647754	0.093488366
35:00:00	0.071992563	0.074561688	0.080661815	0.09422242	0.085000324	0.091710876
35:30:00	0.070623771	0.07314405	0.079128196	0.092430973	0.083384217	0.089967181
36:00:00	0.069281004	0.071753365	0.077623735	0.090673587	0.081798836	0.088256639
36:30:00	0.067963768	0.070389122	0.076147878	0.088949614	0.080243599	0.08657862
37:00:00	0.066671576	0.069050816	0.074700082	0.087258419	0.078717931	0.084932504
37:30:00	0.065403952	0.067737956	0.073279813	0.085599379	0.07722127	0.083317686
38:00:00	0.06416043	0.066450058	0.071886547	0.083971881	0.075753066	0.081733571
38:30:00	0.06294055	0.065186646	0.070519771	0.082375328	0.074312776	0.080179574
39:00:00	0.061743864	0.063947255	0.069178982	0.080809129	0.07289987	0.078655123
39:30:00	0.060569931	0.062731428	0.067863685	0.079272709	0.071513828	0.077159657
40:00:00	0.059418318	0.061538719	0.066573396	0.0777655	0.070154139	0.075692624
40:30:00	0.0582886	0.060368686	0.065307639	0.076286948	0.068820302	0.074253483
41:00:00	0.057180361	0.059220899	0.064065947	0.074836508	0.067511824	0.072841705
41:30:00	0.056093193	0.058094934	0.062847864	0.073413645	0.066228225	0.071456769
42:00:00	0.055026696	0.056990378	0.061652941	0.072017835	0.064969031	0.070098165
42:30:00	0.053980476	0.055906822	0.060480736	0.070648563	0.063733777	0.068765391
43:00:00	0.052954148	0.054843868	0.059330819	0.069305325	0.06252201	0.067457958
43:30:00	0.051947333	0.053801124	0.058202764	0.067987626	0.061333282	0.066175383
44:00:00	0.05095966	0.052778206	0.057096158	0.06669498	0.060167155	0.064917193
44:30:00	0.049990767	0.051774736	0.056010591	0.065426911	0.059023199	0.063682926
45:00:00	0.049040294	0.050790346	0.054945664	0.064182952	0.057900994	0.062472125
45:30:00	0.048107893	0.049824671	0.053900985	0.062962645	0.056800125	0.061284345
46:00:00	0.04719322	0.048877357	0.052876168	0.061765539	0.055720187	0.060119149
46:30:00	0.046295938	0.047948054	0.051870836	0.060591193	0.054660781	0.058976106

Time	75-Year	100-Year	200-Year	1000-Year	100-Year+14%CC	100-Year+23%CC
47:00:00	0.045415715	0.047036419	0.050884618	0.059439176	0.053621518	0.057854796
47:30:00	0.044552228	0.046142118	0.049917151	0.058309061	0.052602015	0.056754805
48:00:00	0.043705158	0.04526482	0.048968078	0.057200434	0.051601895	0.055675729
48:30:00	0.042874194	0.044404202	0.04803705	0.056112884	0.05062079	0.054617168
49:00:00	0.042059029	0.043559947	0.047123724	0.055046012	0.049658339	0.053578735
49:30:00	0.041259363	0.042731744	0.046227763	0.053999425	0.048714188	0.052560045
50:00:00	0.0404749	0.041919287	0.045348836	0.052972736	0.047787987	0.051560723
50:30:00	0.039705353	0.041122277	0.044486621	0.051965568	0.046879396	0.050580401
51:00:00	0.038950437	0.040340421	0.043640799	0.050977549	0.04598808	0.049618718
51:30:00	0.038209874	0.039573431	0.042811058	0.050008315	0.045113711	0.04867532
52:00:00	0.037483391	0.038821023	0.041997093	0.049057509	0.044255966	0.047749858
52:30:00	0.036770721	0.03808292	0.041198604	0.048124781	0.043414529	0.046841992
53:00:00	0.036071601	0.037358851	0.040415297	0.047209787	0.042589091	0.045951387
53:30:00	0.035385773	0.036648549	0.039646883	0.046312189	0.041779346	0.045077716
54:00:00	0.034712985	0.035951752	0.038893079	0.045431658	0.040984997	0.044220655
54:30:00	0.034052989	0.035268203	0.038153606	0.044567868	0.040205751	0.04337989
55:00:00	0.033405541	0.03459765	0.037428193	0.043720501	0.039441321	0.04255511
55:30:00	0.032770403	0.033939847	0.036716573	0.042889245	0.038691425	0.041746011
56:00:00	0.03214734	0.03329455	0.036018482	0.042073793	0.037955787	0.040952296
56:30:00	0.031536124	0.032661522	0.035333664	0.041273846	0.037234135	0.040173672
57:00:00	0.03093653	0.03204053	0.034661867	0.040489108	0.036526204	0.039409852
57:30:00	0.030348335	0.031431345	0.034002842	0.039719291	0.035831733	0.038660554
58:00:00	0.029771323	0.030833742	0.033356348	0.03896411	0.035150466	0.037925503
58:30:00	0.029205282	0.030247501	0.032722145	0.038223287	0.034482152	0.037204427
59:00:00	0.028650004	0.029672407	0.0321	0.037496549	0.033826544	0.036497061
59:30:00	0.028105282	0.029108247	0.031489685	0.036783629	0.033183401	0.035803144
60:00:00	0.027570918	0.028554813	0.030890973	0.036084263	0.032552487	0.03512242
60:30:00	0.027046713	0.028011902	0.030303644	0.035398195	0.031933568	0.034454639
61:00:00	0.026532475	0.027479313	0.029727482	0.034725171	0.031326416	0.033799555
61:30:00	0.026028014	0.02695685	0.029162275	0.034064942	0.030730809	0.033156925
62:00:00	0.025533145	0.02644432	0.028607814	0.033417267	0.030146525	0.032526514
62:30:00	0.025047684	0.025941536	0.028063895	0.032781906	0.029573351	0.031908089
63:00:00	0.024571454	0.02544831	0.027530317	0.032158625	0.029011074	0.031301422
63:30:00	0.024104278	0.024964463	0.027006884	0.031547195	0.028459488	0.030706289
64:00:00	0.023645984	0.024489815	0.026493404	0.030947389	0.027918389	0.030122472
64:30:00	0.023196404	0.024024191	0.025989686	0.030358988	0.027387578	0.029549755
65:00:00	0.022755372	0.02356742	0.025495545	0.029781774	0.026866859	0.028987927
65:30:00	0.022322725	0.023119334	0.025010799	0.029215534	0.02635604	0.02843678
66:00:00	0.021898304	0.022679767	0.02453527	0.028660061	0.025854934	0.027896113
66:30:00	0.021481953	0.022248557	0.024068782	0.028115148	0.025363355	0.027365726
67:00:00	0.021073517	0.021825547	0.023611163	0.027580596	0.024881123	0.026845422
67:30:00	0.020672847	0.021410578	0.023162245	0.027056208	0.024408059	0.026335011
68:00:00	0.020279796	0.0210035	0.022721863	0.026541789	0.02394399	0.025834305
68:30:00	0.019894217	0.020604161	0.022289853	0.026037151	0.023488744	0.025343119
69:00:00	0.019515969	0.020212415	0.021866057	0.025542108	0.023042154	0.024861271
69:30:00	0	0.019828118	0.021450319	0.025056477	0.022604054	0.024388585
70:00:00	0	0.019451127	0.021042485	0.024580079	0.022174284	0.023924886

Time	75-Year	100-Year	200-Year	1000-Year	100-Year+14%CC	100-Year+23%CC
70:30:00	0	0	0.020642405	0.024112739	0	0
71:00:00	0	0	0.020249932	0.023654285	0	0
71:30:00	0	0	0.019864921	0.023204547	0	0
72:00:00	0	0	0.01948723	0.02276336	0	0
72:30:00	0	0	0	0.022330561	0	0
73:00:00	0	0	0	0.021905991	0	0
73:30:00	0	0	0	0.021489494	0	0
74:00:00	0	0	0	0.021080915	0	0
74:30:00	0	0	0	0.020680104	0	0
75:00:00	0	0	0	0.020286915	0	0
75:30:00	0	0	0	0.0199012	0	0
76:00:00	0	0	0	0.01952282	0	0

Time	100-Year+46%CC
00:00:00	0.028077641
00:30:00	0.042361766
01:00:00	0.096647114
01:30:00	0.220625602
02:00:00	0.478069006
02:30:00	1.012005374
03:00:00	1.804653873
03:30:00	2.650393227
04:00:00	3.37293626
04:30:00	3.68806526
05:00:00	3.60420008
05:30:00	3.264087145
06:00:00	2.818299668
06:30:00	2.377978609
07:00:00	1.969261693
07:30:00	1.6032892
08:00:00	1.284255526
08:30:00	1.002587544
09:00:00	0.762950106
09:30:00	0.600027782
10:00:00	0.490355286
10:30:00	0.408514544
11:00:00	0.345732481
11:30:00	0.302992811
12:00:00	0.279126688
12:30:00	0.264468593
13:00:00	0.254944343
13:30:00	0.248563186
14:00:00	0.243787352
14:30:00	0.239152234
15:00:00	0.234605243
15:30:00	0.230144704
16:00:00	0.225768973
16:30:00	0.221476437
17:00:00	0.217265516
17:30:00	0.213134656
18:00:00	0.209082336
18:30:00	0.205107063
19:00:00	0.201207372
19:30:00	0.197381825
20:00:00	0.193629013
20:30:00	0.189947553
21:00:00	0.186336089
21:30:00	0.182793289
22:00:00	0.179317848
22:30:00	0.175908486
23:00:00	0.172563946

Time	100-Year+46%CC
23:30:00	0.169282995
24:00:00	0.166064425
24:30:00	0.16290705
25:00:00	0.159809705
25:30:00	0.15677125
26:00:00	0.153790565
26:30:00	0.150866552
27:00:00	0.147998133
27:30:00	0.145184251
28:00:00	0.14242387
28:30:00	0.139715971
29:00:00	0.137059557
29:30:00	0.13445365
30:00:00	0.131897289
30:30:00	0.129389531
31:00:00	0.126929454
31:30:00	0.12451615
32:00:00	0.12214873
32:30:00	0.119826322
33:00:00	0.117548069
33:30:00	0.115313133
34:00:00	0.113120689
34:30:00	0.110969931
35:00:00	0.108860064
35:30:00	0.106790313
36:00:00	0.104759913
36:30:00	0.102768118
37:00:00	0.100814192
37:30:00	0.098897416
38:00:00	0.097017084
38:30:00	0.095172503
39:00:00	0.093362992
39:30:00	0.091587886
40:00:00	0.089846529
40:30:00	0.088138281
41:00:00	0.086462512
41:30:00	0.084818604
42:00:00	0.083205952
42:30:00	0.081623961
43:00:00	0.080072048
43:30:00	0.078549642
44:00:00	0.077056181
44:30:00	0.075591115
45:00:00	0.074153904
45:30:00	0.07274402
46:00:00	0.071360941
46:30:00	0.070004158

Time	100-Year+46%CC
47:00:00	0.068673172
47:30:00	0.067367492
48:00:00	0.066086637
48:30:00	0.064830135
49:00:00	0.063597522
49:30:00	0.062388346
50:00:00	0.061202159
50:30:00	0.060038525
51:00:00	0.058897015
51:30:00	0.057777209
52:00:00	0.056678693
52:30:00	0.055601064
53:00:00	0.054543923
53:30:00	0.053506882
54:00:00	0.052489558
54:30:00	0.051491576
55:00:00	0.050512569
55:30:00	0.049552176
56:00:00	0.048610043
56:30:00	0.047685822
57:00:00	0.046779174
57:30:00	0.045889763
58:00:00	0.045017263
58:30:00	0.044161352
59:00:00	0.043321714
59:30:00	0.04249804
60:00:00	0.041690027
60:30:00	0.040897376
61:00:00	0.040119796
61:30:00	0.039357001
62:00:00	0.038608708
62:30:00	0.037874642
63:00:00	0.037154533
63:30:00	0.036448116
64:00:00	0.035755129
64:30:00	0.035075319
65:00:00	0.034408433
65:30:00	0.033754227
66:00:00	0.033112459
66:30:00	0.032482894
67:00:00	0.031865298
67:30:00	0.031259444
68:00:00	0.03066511
68:30:00	0.030082076
69:00:00	0.029510126
69:30:00	0.028949052
70:00:00	0.028398645

Time	100-Year+46%CC
70:30:00	0
71:00:00	0
71:30:00	0
72:00:00	0
72:30:00	0
73:00:00	0
73:30:00	0
74:00:00	0
74:30:00	0
75:00:00	0
75:30:00	0
76:00:00	0

Enzygo specialise in a wide range of technical services:

Property and Sites
Waste and Mineral Planning
Flooding, Drainage and Hydrology
Landscape Architecture
Arboriculture
Permitting and Regulation
Waste Technologies and Renewables
Waste Contract Procurement
Noise and Vibration
Ecology Services
Contaminated Land and Geotechnical
Traffic and Transportation
Planning Services

BRISTOL
The Byre
Woodend Lane
Cromhall
Gloucestershire
GL12 8AA
Tel: 01454 269 237

SHEFFIELD
Samuel House
5 Fox Valley Way
Stocksbridge
Sheffield S36 2AA
Tel: 0114 321 5151

MANCHESTER
Ducie House
Ducie Street
Manchester
M1 2JW
Tel: 0161 413 6444

CARDIFF
Regus House
Malthouse Avenue
Cardiff Gate Buisness Park
CF23 8RU
Tel: 02920 023 700

Please visit our website for more information.

enzygo.com